

B O V I N E D Y S T O C I A

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DECLARATION

I hereby declare that this thesis has been composed entirely by myself and that the material herein has not been submitted in candidature for any other degree or diploma.

Signed

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April 1984.

ABSTRACT OF THESIS

The thesis is a detailed review of the extensive literature pertaining to the important subject of bovine dystocia. Approximately one thousand references have been reviewed covering chiefly the period from 1828 until the present time. The origins of the early British journals and details of the persons involved in their establishment are briefly discussed. Until the year 1932 the subject matter is for the most part confined to the British literature but after that date coverage has been expanded to include world-wide sources. The importance and content of the early textbooks is emphasised.

Chapters are devoted to the incidence and causes of bovine dystocia and emphasis is placed on the severe and often avoidable consequences of the condition. The endocrinological and physiological aspects of normal birth are discussed and serve as a useful comparison with dystocia. Subsequent chapters discuss the individual causes of maternal and foetal dystocia. Special attention is paid to the particular problems of foetal oversize and of assessing the likelihood of successful vaginal delivery.

In the latter parts of the thesis further consideration is given to methods of foetal delivery in cases of dystocia. The general approach to a case is discussed and methods of manipulative delivery and surgical delivery by embryotomy and caesarean section are reviewed. The importance of good after-care is stressed. In each chapter the author has drawn upon his experience in general and referral practice to comment upon and to amplify the subject matter. The thesis is profusely illustrated with photographs which include sequences of normal and assisted birth together with examples of current and historical instruments.

The gradual development and advancement of knowledge in the field of bovine dystocia should logically have resulted in a much lower incidence of the condition. The means for its prevention or early detection and satisfactory treatment are available but there is evidence that both incidence and losses through foetal stillbirth have increased. In discussion the author attributes the apparent anomaly to economic pressures arising from high calf values and the high cost of providing good supervision of the parturient cow. He questions whether there is any way in which the important welfare aspects of the problem can be made to outweigh economic pressures.

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CHAPTER ONE

INTRODUCTION

As Smithcors (1957) sagely remarked, 'the graduate veterinarian of today has been accused of believing that the history of his profession began with the date of his matriculation.' But of course veterinary medicine and obstetrics are as old as civilisation itself even though the profession as we know it today is relatively young. Undoubtedly, as long as cattle have been domesticated problems of dystocia have occurred and men, with greater or lesser skills, have made some attempt to assist them in their labour. These early bovine obstetricians had no scientific knowledge but became skilled in the art of obstetrical work which they probably acquired by trial and error. Knowledge so acquired was passed on from father to son. Formal veterinary education did not begin in Great Britain until 1791 but although a number of treatises on practical obstetrics appeared about this time, it was to be many years later before the first true textbook of veterinary obstetrics was published.

The incidence of dystocia in cattle is higher than in other species for reasons which will be discussed later. Moreover the importance of bovine dystocia to both veterinarian and client is possibly even greater than the higher incidence alone would warrant. Much is at stake. A prize cow, a long-awaited calf preserving a particular line of breeding, the dystocia often left uncorrected too long - these and other factors may lead to a tension-filled situation. The veterinary surgeon must often act at once to preserve the life of the cow and her calf. He is on trial both immediately and retrospectively. His reputation may depend on his ability to deal with the case.

Munro (1894b) accurately described the problems confronting the practitioner receiving a call 'You must come at once to Mr. X as he has got a cow which cannot calve. Enquiries suggest that 'Mr. Cleverboddy' has already been there and he is considered 'a good man

with a cow' and when he is beaten after punishing the poor animal for five or six hours you must throw everything down, get your instruments together and hurry off arriving just in time to see the poor beast die or in a state of great exhaustion. On your rounds the next day you meet the neighbouring farmer who tells you that Mr. X's cow is dead and gives a quiet hint that he thinks you must have hurt the cow internally with those steel instruments you used. The idea never occurs that 'Mr. Cleverboddy' working for five or six hours in the cow never did any harm'. Munro continued 'If the veterinary surgeon has been established for some time and has the reputation of being an expert he gets over this comparatively easily, but should he be a young practitioner it often sticks with him for life, although he was in no way to blame'.

Farmers are naturally suspicious especially of the young and Winter (1896), in describing a case of dystocia due to a conjoined monster, noted that his client rejected the offer of help from his assistant saying that it was 'not a job for a young man'. The importance of success in obstetrical cases was also noted by Edwards (1923) who said 'Upon his efficiency in particular (obstetrical) cases and their sequelae his reputation as a practitioner probably depends more than his aptitude to deal with any other class of case. To the ordinary farmer these cases offer a ready test of the practitioner's skill, patience, common sense, resource under varying circumstances and last but not least his willingness or the reverse to undertake work of the dirtiest, most dangerous and most strenuous type which his profession calls upon him to perform'.

The difficulties confronting the bovine obstetrician were emphasised by another author (Anon, 1901). Describing the work he said 'It must be confessed that the art is not alluring and it is attended with many more hardships, inconveniences and difficulties than fall to the lot of the human obstetrict, indeed we know of no more arduous and anxious occupation than that of the country practitioner in a cattle breeding district. He requires physical endowments which are certainly not required by the attendant on women. He has to do with animals so powerful that at best his fatigues are excessive, must often operate in painful and constrained conditions with clumsy, ignorant assistants, and all this too often

in dirty, ill ventilated stables or outhouses, cold and almost in darkness'.

Gibbings (1896) noted that the successful veterinary obstetrician needed both art and science to help him through his work, art to make him adept at manipulative dexterity and science to combat the complications which may occur. He stressed the importance of the new graduate being prepared and experienced in obstetrical matters and warned that 'if he learned after graduation in competition with the local experienced empiric it was often at the expense of his own reputation'. Obviously to be a successful bovine obstetrician special qualities were required and Edwards (1925) summarised these as 'a liberal amount of common sense, patience, judgement, tenacity of purpose and some constructive imaginative facility enabling him to visualise what he cannot see'. McDowell (1922) agreed that good judgement was essential along with manipulative powers but added that 'good muscle and a clear head' were also necessary. He also recalled the problem of over-anxious clients demanding to know what the presentation was and found it best to tell them 'wait and see'. The importance of ability in dealing with obstetrical cases was more recently commented on by Armstrong et al. (1978) who wrote 'If a practitioner is not capable in the management of dystocia, he is unlikely to be a successful bovine practitioner'.

At times during the 19th century the standing of the profession in the eyes of the agricultural community was not very high. Hall (1855) stated 'It is the general opinion of the agricultural community in this country that veterinary surgeons know very little about cattle, believing that at college they confine themselves to the study of the horse only'. This was of course true at that time at the London College and was one of the causes of the longstanding feud between William Youatt, practitioner and co-editor of *The Veterinarian* and Professor Coleman of the London College. Hall (1855) added 'I hope that such ideas will be eradicated from their minds before long'.

Lawson (1860) stressed that any tuition given should include practical experience. He said 'To enable the practitioner to undertake foaling and calving work in a proper manner, he must have actual practice therein, for no amount of reading or oral teaching will make him expert although these means are not to be slighted'. The

importance of practical tuition was later stressed by a number of other authors. Edwards (1902) recalled vividly the lectures he received at college and as his teacher tackled one presentation after another 'it all became so placidly easy and seemed to offer such a field for the exhibition of skills that would astonish the natives'. Later Edwards (1902) realised that 'Obstetrics must be learned practically and one is always meeting some case presenting new difficulties calling for the exercise of one's native common sense to overcome'. But in the early part of the 19th century the deficiencies of the curriculum of the London Veterinary College had already been recognised. 'Philovet' (1828) wrote 'concerning the defects of the (London) Veterinary College, I know of none that requires a speedier remedy than the total neglect of anatomy, physiology and diseases of cattle'. He added 'the professors had no opportunity to gain experience and without experience they were too prudent and candid to expose themselves or mislead their pupils'. An editorial in *The Veterinarian* (Anon, 1830) which was an Obituary to the late King George IVth noted that His Majesty, a patron of the London college, 'was becoming much displeased with the late management of that institution'.

Veterinary students in Scotland were however receiving a broader education which included instruction on the diseases of cattle including obstetrics. Youatt (1830) wrote 'North of the Tweed, Mr. Dick has established a school at Edinburgh under the patronage of the Highland Society of Scotland in which diseases of all the domestic animals are ably treated'. It was not until 1877, when George Fleming published his 'Textbook of Veterinary Obstetrics' that the veterinary profession in Britain had a book entirely devoted to this subject. The lack of scientific literature on veterinary obstetrics had been commented upon earlier. An anonymous contributor to *The Veterinarian* (Anon, 1859, probably Professor John Gamgee) regretted the lack of a 'good British obstetrical text' but cited three continental volumes by Günther, Reinard and Baumeister which had been found most useful.

Despite the lack of textbooks practitioners managed to deal with obstetrical problems and following the publication of *The Veterinarian* in 1828, began to record cases of interest which often provoked

either editorial comment or further correspondence from colleagues who had seen similar cases. Some became regular correspondents whilst others had just a single contribution to make, but a study of this early literature reveals much careful observation a great deal of which is still pertinent today. Unfortunately much of this early work has been forgotten. During the 19th century and also during the early years of the present century, no indexing journals were available and the researcher can only pursue his studies by painstakingly working his way through old journals often damaged by the ravages of time. Such a study is however highly rewarding. From within the leaves of these old volumes emerges a *dramatis personae* working in conditions of great difficulty, isolated, surrounded by empirics, often criticised and in many cases poorly prepared for obstetrical work. Their industry and their willingness to record their findings has served as the basis for modern obstetrical knowledge.

The purpose of this thesis has been to record, to review and to comment upon the British literature on Bovine Dystocia from the earliest times until the present. Originally the author had hoped to include early literature from other countries but study soon revealed that, such was the amount of literature on bovine dystocia and obstetrics in Britain alone, that to include all the work of other countries would result in an unmanageable quantity of data. As the study advanced to modern and more scientific times, the author has of course widened the sources of data to include material from many other parts of the world.

The history of bovine obstetrics is a mirror of the history of the profession. It traces the early struggles of the profession from the days of the cow leech to the development of modern scientific thought and scholarship. This thesis will trace the development of the early literature in which it was the custom to record individual cases of interest and follow the literature through until the present time when statistically monitored and comparative studies are required. It is hoped that it will be a tribute to the many authors who have contributed to our knowledge of bovine obstetrics.

The thesis is essentially a detailed review of the literature concerning bovine dystocia and obstetrics and the information

contained herein has come from many sources. Approximately one thousand references have been reviewed and the main sources of these will be discussed in Chapter Two. Normal bovine birth is the subject matter of Chapter Three and will provide a base from which the incidence and causes of dystocia together with economic considerations may be dealt with in subsequent chapters.

The treatment of bovine dystocia by manipulative and operative means will be discussed in later chapters. A separate chapter will be devoted to the after-care of the dam following foetal delivery.

Finally, in the discussion, the author will review the accumulation and development of knowledge in the field of bovine obstetrics which has taken place over the past 150 years. He will question whether this knowledge has been fully applied to the prevention and treatment of bovine dystocia for the benefit of the patient's welfare and for the economic advantage of its owner.

CHAPTER TWO

THE LITERATURE

The student of the early history of the veterinary profession owes an enormous debt to the labours of the late Major-General Sir Frederick Smith. In a series of four volumes entitled 'The Early History of Veterinary Literature and its British Development', spanning the period from the 'Earliest Times' until 1860, Smith has provided posterity with a comprehensive catalogue of publications of a veterinary or para-veterinary nature. Many years later Smithcors (1957) published his volume 'Evolution of the Veterinary Art - a narrative to 1850', but admitted that he drew heavily on the works of Smith and others whilst compiling his work.

Smith realised the enormity of the task confronting him and in the preface of the first volume of his book he wrote 'Historical research requires much time, and I realised that I must await the period of my retirement from the services before any serious attempt could be made'. He also noted that the material for the first volume had taken ten years to collect. Smith was a remarkable man and some details of his life are recorded by Bullock (1933). Born in 1857 and left fatherless at the age of ten, Smith nonetheless gained a place at the London Veterinary College and qualified with great credit at the age of nineteen. Shortly after qualifying Smith joined the Army and saw much overseas service until he retired in 1910 at the age of 53. He then prepared the first volume of his 'History' but shortly after its publication he was recalled to the Army for the duration of the First World War.

The details of publication of the four volumes of Smith's work are given below (Table 1). It will be noted that the first three volumes appeared initially in serial form in journals current at that time. Regrettably Smith died in 1929 before the publication of his fourth and last volume. Fortunately he left copious notes and the work was edited and published in 1933 by Smith's friend Fred Bullock who was Registrar of the Royal College of Veterinary Surgeons. All four volumes of Smith's work were reprinted in 1976 by Messrs. J.A. Allen & Co. For ease of reference Smith's work will be referred to

as 'Smith, 1976' with the suffixes (a,b,c,d) directing the reader to volumes 1,2,3 or 4 respectively.

Table 1

Publication Details of Smith's Early History of Veterinary Literature
& its British Development

<u>Volume 1</u>	The earliest period to A.D. 1700. Published in serial form in the 'Journal of Comparative Pathology and Therapeutics' 1912-1918. Published as one volume 1919.
<u>Volume 2</u>	The 18th Century. Published in serial form in 'The Veterinary Journal' 1923-4. Published in book form 1924.
<u>Volume 3</u>	The 19th Century 1800-1823. Published in serial form in 'The Veterinary Journal' 1929-30. Published in book form 1930.
<u>Volume 4</u>	The 19th Century 1823-1860. Published in book form (Edited by F. Bullock) 1933.

Little is known of the work of veterinary obstetricians in the earlier periods of history, but Smithcors (1957) noted that in India in the year B.C. 250 veterinary hospitals were established and 'the science of obstetrics was developed to the point where sterility was treated and careful attention given to pregnant animals and neonates'. From this it must be deduced that obstetrical attention was given to cases of bovine dystocia. In the period just before and after the birth of Christ, according to Smithcors (1957), the Romans recognised a group of persons with veterinary skills. The Roman author Columella (cited by Smith, 1976a and Smithcors, 1957) recommended that the shepherd should watch over his pregnant ewes with 'as much care as the midwives exercise'. If, during delivery, the lamb became stuck crosswise in the genital organs Columella advised that the shepherd 'may either extract it whole or be able to remove it from the womb after dividing it with a knife'. According to Smithcors (1957) Columella also gave advice concerning the husbandry and care of cattle including infertile animals. It is probable therefore that obstetrical manipulation and embryotomy were also practised in

this species at the time of his writings.

As already mentioned in the introduction to this thesis, the Veterinary profession in Britain is relatively young, being less than 200 years old. Writings on veterinary matters prior to the founding of the trained profession tended to be the work of literate farmers, clergy and gentlemen. Plagiarism was rife and it was difficult to be certain whether the author whose name was associated with a particular work had in fact written it (Hall, 1961).

Smith (1976a) noted the existence of an anonymous manuscript assigned to the reign of Edward 1st (1272-1307) entitled 'The Seneschauie or Farm Steward'. In this manuscript the duties of the Steward were clearly set out as were those of his staff, including the cow-herd. The cow-herd was selected for his skill and part of his duty was to sleep with his cows and undoubtedly to be on hand to assist should problems occur at calving. Leonard Mascall was one of the 16th century's most prolific writers and in 1587 published 'The First Booke of Cattell'. According to Smith (1976a) Mascall was a plagiarist and but for his posthumous appointment as Chief Farrier (a post he never held) to King James, his works would have quickly disappeared. Mascall published many volumes on various subjects but his 'Booke of Cattell' had, according to Smith (1976a), little to say on the subject of bovine dystocia. Mascall did however mention retention of the placenta in cattle and noted 'If ye shall see knots in her mouth then judge she has not cleansed of her birth, then ye must take them from her else she will die'.

Crawshay (1636) published a small volume 'The Countryman's Instructor'. It was dedicated to 'honest meaning countrymen and friends of the author in the counties of York and Lincoln where he practised for their benefit and admiration'. Smith (1976a) considered that Crawshay's work was 'crude and uncultured' but none-the less regarded him as a 'careful and observant practitioner'. Smithcors (1957) commenting on Crawshay's ability and remedies, noted that 'his surgery is as accomplished as his medicine is crude'. Crawshay (1636) gave his readers detailed instructions on the performance of caesarean section in cattle. He stressed the importance of ascertaining in which horn of the uterus the calf lay and of clipping the hair off the flank of the cow before operating. After

the calf was delivered the uterus was sewn up with silk thread. Following surgery careful dieting was prescribed for three days and Crawshay added 'She will be well God willing'. It is not certain of course that Crawshay had ever actually carried out a caesarean section but the detailed nature of his instructions would suggest that he had in fact done so. According to Smithcors (1957) the most remarkable and original veterinary work of the 17th century was a little-known volume 'The Herdsman's Mate' which was published by Michael Harward in 1673. Harward was an Englishman practising in Ireland and Smith (1976a) quoted at length from his writings. From these quotations it is possible to deduce that Harward was a shrewd, competent and observant practitioner. His descriptions of intestinal surgery are particularly interesting and heroic and Smithcors (1957) noted 'Harward appears to have been a pioneer in the field of intestinal surgery, nothing comparable to his accomplishments being noted in human practice at that time! According to Smith (1976a) Harward shone in obstetrical cases. He discussed the use of cords and hooks in malpresentation cases and when applying traction to a foetus instructed the operator to 'be sure to draw downwards, draw hard, though not rashly'. He also described the techniques for embryotomy and in addition, the operation of vaginal hysterotomy in cases of obstruction of the birth canal caused by cirrhosis of the cervix.

In 1791 the London Veterinary College was founded but just prior to this in 1788 a book entitled 'A New Compendious system on Several Diseases incidental to Cattle' was published by an author using the pseudonym Thomas Topham. Smith (1976b) suggested that Topham was 'an old country physician' but considered the content of his book to be 'worthless'. Topham himself had apparently a very low opinion of veterinarians of that time and noted 'Cow doctors and farriers are in general the most illiterate, injudicious and self sufficient people we have amongst us'. According to Smith (1976b), Topham dealt with parturition 'sensibly and gave practical advice regarding the treatment of malpresentation'. However Smithcors' (1957) view of Topham's work was that 'like other physicians he was strong on philosophy but weak on practice' - a view supported by the fact that having described the method employed to correct one malpresentation he said

that he would 'leave the practitioner to invent the rest'.

Nine years after the publication of Topham's work, Downing (1797) published 'A Treatise on the disorders incident to horned cattle, comprising a description of their symptoms and an appendix containing instructions for the removal of calves'. Ten years later Skellett (1807) published a volume entitled 'A practical treatise on the parturition of the cow or the extraction of the calf: and also the diseases of neat cattle in general'. Considerable controversy surrounded the works of Topham, Downing and Skellett and allegations of plagiarism have been made against the latter two authors. Smith (1976b) accused Downing of 'shameless plagiarism' in copying the main part of his book from the work of Topham. However he considered the appendix of Downing's book, devoted to the delivery of calves in dystocia cases, to be a 'revelation'. According to Hall (1961) Downing's appendix 'although unacknowledged, had a profound influence upon bovine obstetrics'. Smithcors (1957) considered that Downing's plagiarism of Topham's works was perhaps repaid when Downing's own obstetrical notes were 'purloined for lectures by the London Veterinary College'. Research by Hall (1961) has suggested that Downing was probably a human surgeon with a particular interest in bovine obstetrics. Downing's instructions for delivering malpresented calves were clear, careful and lucid. However Hall's research (Hall, 1961) suggested that Downing may at one time have been involved in snatching human bodies for dissection.

Smith apparently changed his mind concerning the relationship of the works of Downing to those of Skellett. In the second volume of his History, Smith (1976b) referred to a 'Skelton' who 'purloined the works of Downing'. By the time his third volume was published (Smith, 1976c) Smith had not only spelled Skellett's name correctly but had decided that his work on bovine obstetrics was 'the most superb work ever published in the English language on parturition in the cow'. Those who have had the opportunity to see Skellett's work would agree that it was well written and produced and that the plates depicting dystocia were indeed superb. Smith (1976c) latterly considered Skellett to be possessed of 'a truly scientific mind', a view possibly shared by Skellett himself who, in the preface to his book, styled himself as 'Professor of that part of the veterinary art'.

Skellett undoubtedly was very experienced having been working as a veterinarian for some 25 years before publication of his book.

Skellett (1807) was able to offer his readers much sensible advice. He stressed the importance of looking after the pregnant cow with care, noting 'the time of gestation is with her a state of indisposition and every manager of cattle should be aware of this and treat her with every care and attention during this time'. Other quotations from Skellett's work will appear later in this thesis.

Hall (1961) stimulated considerable debate on the Topham - Downing - Skellett relationship and later correspondence in *The Veterinary Record* discussed the importance of particularly Downing and Skellett as founders of scientific bovine obstetrics. Earlier Edwards (1930a) had noted 'In England veterinary obstetrics had no existence upon paper until 1807 when one Edward Skellett published his treatise'. Barber-Lomax (1961) probably gave the fairest assessment of the work of Downing and Skellett when he said 'two acute observers, one a practical countryman (Downing) and the other (Skellett) a well educated scientist were working in the same field at the same time. The fact remains that these two obstetrical treatises are classics and can be read today with advantage'. There the debate must be left but undoubtedly the works of these two workers did indeed sow the seeds for future obstetrical study and advancement.

The 19th century saw the establishment of a number of veterinary journals founded to assist in the dissemination of knowledge among the newly-formed profession. The editors of some of these journals also used their publications to fight prolonged political battles but, despite this, the journals were of great value to a profession who had so few textbooks to help them. Some of the journals were to run for many years, others lasted for a few editions only. The most important of the journals which were the source of much information in the present thesis are listed and discussed briefly below (Table 2).

Table 2List of British Veterinary Journals established in the 19th CenturyThe Veterinarian 1828 - 1902.The Veterinary Record (The first) 1845 - 1850.The Edinburgh Veterinary Review & Annals of Comparative Pathology
1858 - 1864.The Veterinary Review & Stockowner's Journal 1865.The Veterinary Journal & Annals of Comparative Pathology 1875 - 1948
(continued as the British Veterinary Journal to the present time).The Veterinary Record (The second) 1881 to the present time.The Veterinarian

This, the first British veterinary publication, was founded in 1828 by William Percivall (1792 - 1854). Percivall who was both a veterinarian and a surgeon was joined almost immediately by William Youatt. Percivall qualified at the London Veterinary College in 1811 at the age of nineteen years and having served in the Crimean war he qualified as a surgeon (Smith, 1976c). William Youatt (1776 - 1847) was originally a non-conformist minister and entered the London Veterinary College in 1811 but, following a quarrel with the then principal Professor Coleman, Youatt left and did not actually qualify as a veterinary surgeon until 1844 when he was 68 years of age - only three years prior to his death. The profession undoubtedly owes a tremendous debt to Percivall and Youatt who, through the columns of The Veterinarian, did much to educate the profession in areas such as bovine obstetrics which were not covered at all in the London College. Perhaps not surprisingly Youatt's dislike of Coleman was apparent in many of The Veterinarian's editorials.

Percivall and Youatt were aided by a number of assistant editors including William Dick of Edinburgh who served in this capacity from 1833 - 1845. When Percivall died in 1854 the editorship passed to the staff of the London Veterinary College who, ironically, had for so long been arch enemies of both Percivall and Youatt. It is interesting to note that among the names of assistant editors there appears in the years 1871 - 1874 that of George Fleming. Fleming left The Veterinarian in 1874 to found and edit The Veterinary

Journal which was first published in 1875.

A very considerable amount of space in The Veterinarian was devoted to bovine obstetrics and the editors encouraged practitioners to send details of their cases in for publication. Smith (1976d) has reviewed much of the material that was published in The Veterinarian. Most of the cases sent in were single cases of a particular type of dystocia but gradually more review articles began to appear. The names of a number of practitioners began to appear with regularity in matters related to bovine obstetrics, in particular that of W.A. Cartwright, a practitioner of Whitchurch in Shropshire. Of Cartwright, Gamgee (1860) wrote 'The person that has contributed most to our knowledge in Great Britain on questions of veterinary obstetrics has been that once constant contributor to The Veterinarian, Mr. W.A. Cartwright'.

The Veterinary Record

First published in 1845, The Veterinary Record & Transactions of the Veterinary Medical Association was edited for all six years of its publication by Professors Spooner, Simonds and Morton of the London Veterinary College. The contents of The Veterinary Record were not dissimilar to those of The Veterinarian and occasionally identical articles appeared in both journals.

The second Veterinary Record, which was founded by William Hunting in 1881, is that which is still published at the present time. The history of its development has been reviewed by Snodgrass (1982).

The Edinburgh Veterinary Review & Annals of Comparative Pathology

Only six volumes of this journal, edited by John Gamgee, were published. The journal commenced publication in 1858 one year after Gamgee left the William Dick college to found his own New Edinburgh College. In 1865 Gamgee's journal changed its name to 'The Veterinary Review & Stockowner's Journal', but this title was only published for eleven months after which publication ceased.

The Veterinary Journal & Annals of Comparative Pathology

The Veterinary Journal commenced publication under the editor-

ship of George Fleming in 1875. Fleming, whose industry in other areas of veterinary science will be discussed shortly, remained as editor until 1881. A number of illustrious editors followed Fleming including W.O. Williams, Hobday, Dalling and McCunn.

One of the most important milestones in the history of British Veterinary Obstetrics was passed in 1877 with the publication by George Fleming of his Textbook of Veterinary Obstetrics. Fleming's qualifications to act as author of such a volume must be subject to question. In a biographical note Anon (1896c) recalled that Fleming had spent most of his professional life in the Army where his main concern was the war horse. Fleming was born in Glasgow in 1833 and shortly after qualifying as a veterinary surgeon at Edinburgh he entered the Army. He saw service in many overseas areas including the Crimea, China, Syria and Egypt. By 1883 he was Principal Veterinary Officer to the Army and he retired on pension in 1890. His Army duties cannot have been too onerous as - despite his known industry - may be judged by the prolificacy of his pen.

The originality of the first edition of Fleming's Textbook of Veterinary Obstetrics is open to question. Edwards (1930a) reviewing the fourth edition of Fleming's book noted that 'Fleming was a universal provider of textbooks and his practical acquaintance with obstetrics was hardly intimate or extensive'. The first edition undoubtedly bore a close resemblance to the work of St Cyr (1875) and the review of the second edition of Fleming's book (Anon, 1895) suggested that Fleming's work was certainly not original and was in fact a translation of the work of St Cyr. A facsimile of the title pages of the work of St Cyr (1875) and Fleming (1877) showed a very close relationship as did the index and layout of the two publications.

Without doubt Fleming's book served a very useful purpose and provided British readers with a comprehensive textbook where none existed before. As Fleming himself prophesied in the preface to his book 'A treatise which might aid to however small an extent in pointing out how those losses (during pregnancy and parturition) may be averted or remedied must surely then prove welcome to those who are engaged in breeding and rearing animals and in their multiplication and welfare'. Williams (1945) noted that he purchased the first edition of Fleming's book when it was published in 1877 and had 'kept

it in a prominent place upon my bookshelf ever since'. Williams added 'Although Fleming was an army officer and made no pretence to clinical experience he drew heavily on the work of St Cyr and others to produce an excellent treatise'.

The later editions of Fleming's textbook, edited at first by himself and then by MacQueen and Craig, continued to rely heavily on the work of continental authors. Edwards (1930a) considered 'more use might have been made of the contributions of English authors' and he drew special attention to the writings of Cartwright, Cunningham, McGillivray and others. The early editions of Fleming were excessively long and provided much unnecessary detail and Edwards (1930a) noted that much superfluous material had been removed from the fourth edition (Craig, 1930). In fairness to Fleming, it must be said that in the preface to the first edition of his book he acknowledged his indebtedness to St Cyr. He also paid tribute to the assistance he had received from W.A. Cartwright when writing the practical sections of the book.

Despite the criticisms mentioned above, Fleming was undoubtedly a great man. In 1883 he was presented with a testimonial by 310 members of the profession. The presentation to Fleming of a silver centrepiece and a silver tray worth 200 guineas has been vividly described by Greaves (1883). By the time of this, his second testimonial, Fleming had received many other honours. He had been elected to a primary fellowship of the Royal College of Veterinary Surgeons and had served as President of the College having sponsored the 1881 Veterinary Surgeons Act using his own funds. He also served as first president of the National Veterinary Medical Association in 1883. At the time of the presentation of his testimonial Greaves (1883) told Fleming 'We recognise in you, sir, one who has consecrated all his life, all his energies and all his means for the advancement of our profession. You have the power of intense application and have, from childhood, been filling the cells of your brain with useful knowledge. Your earnest sagaciousness and unwearied efforts to raise our profession, coupled with your zeal and enthusiasm prompted us to do something worthy of your faculties'. Noting that Fleming's portrait would hang with that of Sir F. Fitzwygram in the Royal College of Veterinary Surgeons, Greaves (1883) continued 'Generations

will gaze upon that grand spectacle long after you are both removed from amongst us. They will know that you have both done noble service and left an unperishable name'.

The need for a less voluminous textbook of Veterinary Obstetrics was filled by Dalrymple (1898) who published 'Veterinary Obstetrics; A compendium for the use of students and practitioners'. Dalrymple who had qualified in Britain but practised in the U.S.A. intended his book to be a handbook chiefly for students. He warned his readers not to neglect larger volumes devoted to veterinary obstetrics. Dalrymple's book was not altogether well received and a reviewer (Anon, 1898) suggested that the author 'should have sought the help of a skilled anatomist and physiologist to check the accuracy of his work before it was published'.

The first textbook devoted solely to bovine obstetrics appeared in Britain in 1901. Written by M.G. de Bruin of Utrecht, 'Bovine Obstetrics' was undoubtedly well in advance of its time. De Bruin's observations on such subjects as the initiation of parturition, foetal monitoring, the composition of the foetal fluids and intra-uterine pressures raised the study of bovine obstetrics to a truly scientific perspective. The book was well written and illustrated and was characterised by a lucid style of prose in which the practical experience of the author was clearly discernible. This remarkable work faded into obscurity following its publication but in the view of the present author it had no equal in the field of bovine obstetrics until the recent work of Sloss and Dufty (1980).

No discussion of the literature of bovine obstetrics would be complete without mention of the work of W.L. Williams. Williams, following a number of years in practice and in state service became the first Professor of Veterinary Obstetrics in the United States of America. Despite illhealth Williams was still publishing in 1945 at the age of 89 years. His first book 'Veterinary Obstetrics, including diseases of breeding' was published in 1909. In 1917 the book was revised and divided into two separate sections dealing with obstetrics and genital diseases respectively. One reviewer (Anon, 1917) noted that although Williams possessed some controversial views his work had outstanding merit in the practical nature of his instructions which were based upon scientific fact.

In more recent years British veterinary students have received instruction through the work that originated from the pen of Professor F. Benesch of Vienna. The book first appeared in Britain in 1938 as Benesch's Veterinary Obstetrics (Equine & Bovine) edited by J.G. Wright. The book has since been expanded and published as follows: (Table 3)

Table 3

Publication details of subsequent editions of Benesch's Veterinary

<u>Obstetrics</u>		
<u>Date</u>	<u>Title</u>	<u>Authors</u>
1951	Veterinary Obstetrics	F. Benesch & J.G. Wright
1964	Wright's Veterinary Obstetrics	G.H. Arthur
1975	Veterinary Reproduction & Obstetrics	G.H. Arthur
1982	Veterinary Reproduction & Obstetrics	G.H. Arthur, D.E. Noakes & H. Pearson

Another standard work for British students and practitioners has been that of Roberts (1956 & 1971). Roberts' work 'Veterinary Obstetrics & Genital Diseases' has been regarded as a most useful and comprehensive volume but has been criticised for its double column printing format and for its lack of illustrations.

During the 20th century the speed of scientific discovery and the greatly increased volume of scientific publications has necessitated the production of indexing journals, collating and classifying publications from all over the world. The Index Veterinarius and the Veterinary Bulletin published in 1931 and 1932 respectively have greatly aided the research worker. Recently some of the material for these journals has been placed into computer systems and whilst this will eventually simplify searches of the literature the material emanating from the computer can only be equated with the accuracy of the input. The present author has made some use of computer searches of the literature for recent years but has been disappointed to discover that much relevant material was

overlooked by the computer search.

Sloss and Dufty (1980) in their 'Handbook of Bovine Obstetrics' reviewed much of the more recent literature. These authors paid special attention to factors influencing the incidence of dystocia in cattle including the problem of foetal oversize which has assumed greater importance in recent years. In the second part of their book Sloss and Dufty (1980) discussed the various procedures which could be applied to either dam or foetus in the treatment of dystocia. Consideration was also given to the important problem of the prevention of dystocia. Each chapter was prefaced by a useful review of the relevant literature.

The development of radio and television in the 20th century has provided new media for the dissemination of knowledge. Programmes were developed, aimed at a farming audience, in which veterinary surgeons discussed problems affecting livestock, including the approach to and treatment of cases of bovine dystocia. The knowledge thus disseminated was in no way restricted but was available to all who possessed a radio or television receiver. Two problems arose from this type of broadcast. Firstly the advice given to farmers tended to be the personal opinion of the broadcaster and thus might not be acceptable to all professional colleagues. Secondly the advice given might well be misinterpreted by the farmer who might, as a result, unwittingly damage or injure his animals.

In 1957 the 'Midland Radio Vet' when discussing the treatment of bovine dystocia correctly suggested that heifers be given plenty of time to calve. He added however that he had on occasion left heifers in labour for up to three days before attempting to deliver their calves. Many farmers believed that he implied that all heifers should be left unaided without veterinary attention for this length of time. Initially the identity of the Midland Radio Veterinary Surgeon was unknown and criticism of his talk by Herrod-Taylor (1957) brought disclaimers from two other 'radio vets' from different parts of the country (Massey, 1957; Hancock, 1957). The identity of the original broadcaster became known following a letter from Straiton (1957). Straiton (1957) reiterated his views which he based on many years of practical experience. Herrod-Taylor (1957) whilst accepting Straiton's freedom to comment considered that such broadcasts

should be censored by other members of the profession. Much discussion followed and some nineteen letters appeared on the subject in *The Veterinary Record*. Of these five supported unreservedly the Radio Vet's views, eight considered his views had much to recommend them but should have been much more cautiously expressed and the remainder disagreed with his views completely.

Some three years later the same controversy appeared again following a television programme in which 'The T.V. Vet' (formerly the 'Midland Radio Vet') discussed his approach to calving cases. Again the broadcaster, following criticism, reiterated his views in the veterinary press (Straiton, 1960). Philips (1960) considered it 'alarming that one man was able to hammer home facts to such a large audience when the facts are not generally agreed. If a professional man is stating his opinion to such a large percentage of cow clients, then let us have some sort of professional criticism as the same time or some discussion'. As was the case following the earlier radio broadcast, the television programme provoked much correspondence within the profession. Eight letters appeared in *The Veterinary Record*, two of which supported the views of the T.V. Vet, two which agreed with reservations and four which disagreed strongly. Pickering (1960) noted that as a result of the television programme he was now 'confronted by calving cases made more difficult by delay. Clients were now not happy with the advice they had been given in the programme and at least one calf had been lost'.

The subject matter of the broadcasts will be discussed later in this thesis but despite the controversy they caused within the profession, they were well received by the farming community. Later the broadcasting authorities agreed to notify the profession in advance of the contents of forthcoming veterinary programmes but none were to be as controversial as those devoted to the problems of bovine dystocia.

CHAPTER THREE

NORMAL BIRTH

No study of bovine dystocia would be complete without some reference to normal birth (eutocia). Both stockman and veterinarian must be familiar with the normal if they are to recognise and treat the abnormal. Normal birth in cattle has been described by the authors of most standard works on bovine and veterinary obstetrics (Fleming, 1877; de Bruin, 1905; Williams, 1917; Roberts, 1971; Arthur, 1975; Sloss & Dufty, 1980). Surprisingly Benesch (1938) made no mention of normal birth in his book and has been criticised for this by one reviewer (Anon, 1940).

Williams (1917) attempted to define normal birth by listing seven conditions which should be fulfilled if the birth was to be considered normal. These conditions were:

'1) Pregnancy shall follow a single service.

2) The duration of pregnancy shall be 285 days with a variant of five days above or below that figure.

3) The foetus is expelled without human aid within one hour of the commencement of labour.

4) The afterbirth drops away within two hours of the birth of the calf.

5) No recognisable discharge occurs from the genital organs beyond a few drops of blood or lymph for two to three hours after passage of the after-birth.

6) The calf when expelled, shall be clean and free from stains or indication of diarrhoea before birth. It shall be lively, active and on its feet without aid within one hour. It shall not break down within 48 hours from diarrhoea or other disease referable to infection within the uterus.

7) The afterbirth shall be free from important evidence of disease'.

Williams' parameters were excessively harsh, unrealistic and for the most part unattainable - a view later shared by Williams himself.

Perhaps a more attainable definition of normal birth in cattle was that given by Sloss and Dufty (1980) who said 'it is completed spontaneously and is unaccompanied by any complications which might impair the health, viability and subsequent productivity of the dam and its offspring'.

The Initiation of Birth and Endocrinological Aspects

Gestation in the cow lasts approximately 283 days and for many years scientists have pondered the possible reasons why parturition should occur after such a regular period of time. Fleming (1877) considered that birth occurred as a result of uterine irritation and inflammation which eventually caused the foetus to be ejected like a foreign body. Marshall (1922) reviewed a number of theories concerning the initiation of parturition current in the early part of the twentieth century. One theory simply suggested that 'parturition occurs at a time which has proved over long ages to be the most suitable for the perpetuation of that species'. Another theory cited by Marshall (1922) was that of Spiegelberg who suggested that parturition was brought about by the action of a substance secreted by the foetus which passed into the maternal blood and initiated birth. This prophetic theory was supported some fifty years later by the studies of Liggins, Kennedy & Holm (1967) working with sheep. Based on this work and that of others, Arthur (1975) and later Sloss and Dufty (1980) suggested the following pattern of hormone change as parturition approached.

As pregnancy approached its termination, the output of ACTH from the foetal anterior pituitary gland increased, probably as a result of foetal stress through lack of space and hypoxia. This in turn resulted in increased output of cortisol from the foetal adrenal and, probably as a consequence of this, a marked rise in the level of maternal corticosteroids also occurred. Maternal oestrogen levels also increased probably as a result of increased placental synthesis. At the same time as maternal steroid and oestrogen levels rose, an increase in the level of prostaglandin F_{2α} was noted but it was not known whether these two events were directly related to each other in the case of cattle. Prostaglandin F_{2α} was believed to play an important role in stimulating contraction of the myometrium, either directly

or by promoting luteolysis with resultant lowering of progesterone levels and increased sensitivity of the myometrium to oxytocin. It should be stressed that many details of bovine endocrinology are as yet unproven and Hoffmann et al. (1979a & b) warned that it should not be assumed that the processes involved in the initiation of parturition in cattle could be necessarily equated with events known to occur in sheep or other mammals. They suggested that more research was needed to clarify certain aspects such as the permeability of the placenta to rising cortisol levels in the prepartum calf. Research work on bovine endocrinology is expensive and it may be many years before the full picture in cattle is known (Taylor, M.J., personal communication).

At one time it was assumed that oxytocin played an important role in the initiation of parturition. However, the work of Fitzpatrick (1954) and Fitzpatrick and Walmsley (1962), Van Dongen and Hays (1966), and Schams and Prokopp (1979) has suggested that the rise in oxytocin level in the cow does not assume importance until the birth process has actually begun. Sloss and Dufty (1980) noted that the hormone relaxin was detectable in the blood of the pregnant cow by the end of the first month of pregnancy. The levels of this hormone rose slowly until the end of the second trimester of pregnancy after which time they remained steady, falling sharply shortly after birth. The role of relaxin was to promote relaxation of the pelvic ligaments prior to calving. Sloss and Dufty (1980) also reviewed the literature relating to prolactin in the cow. They noted that prolactin levels rose sharply two to four days prior to parturition with peak values being seen on the day of parturition. One of the most important functions of prolactin was to promote protein and nucleic acid synthesis and to be involved with enzyme production in the udder.

The possible role of stress in the initiation of birth and in the cause of dystocia has led a number of authors to study the relative levels of corticosteroids in the blood of normal cows and of cows suffering dystocia and their respective calves. Takeishi (1980) noted that cortisol levels were significantly higher throughout labour in cows suffering from dystocia than in normal parturient cows. No significant difference however was noted in the serum

cortisol levels of calves born normally or following dystocia. Stott and Reinhard (1978) in contrast to this found that at parturition calves born after dystocia had lower cortisol concentrations than normal calves. They concluded that any presumptive hyperactivity of the adrenal cortex in calves born after dystocia related to the stress of a long and difficult parturition did not in fact occur. O'Brien and Stott (1975, 1977) suggested that hormonal changes in preparation for parturition were both delayed and less pronounced in cattle suffering dystocia than in animals calving normally. They noted that heifers suffering dystocia had depressed corticosteroid levels, a lack of normal progesterone decrease and lower oestrogen levels prior to calving than heifers calving without difficulty.

The role of the autonomic nervous system must not be forgotten in any consideration of parturition. It has been suggested that the balance between sympathetic and parasympathetic systems may be regulated by the hormonal influences existing at a particular phase of parturition (Sloss & Dufty, 1980). During pregnancy the sympathetic system predominates when progesterone levels are high but that when oestrogen levels rise with approaching birth, then the parasympathetic system assumes a dominant role. Parasympathetic stimulation may result in increased myometrial activity - activity which itself may be temporarily suppressed by clenbuterol (Greene, 1981).

Behavioural and Physiological Changes

By nature the cow is a peaceful phlegmatic animal and physiological birth is slower and less violent than in the mare. The two species were aptly compared by Cartwright (1850b) who wrote 'The one (the cow), tolerably calm at intervals, possessing patience and perseverance in assisting us, of a more gentle and tractable nature: the other (the mare) all force and violence, with but little intermission until the affair is over'. Arthur (1961) noted 'where possible the modern cow, when at large, seeks seclusion for her confinement among bushes or in tall vegetation'. Movement just prior to parturition into strange surroundings may lead to problems of increased levels of dystocia and stillbirth (Dufty, 1972). A harsh environment may lead to problems of survival for both the cow and her

calf. During the winter of 1973-74 a number of cows in the author's East Anglian practice died from exhaustion and exposure during calving. One prosecution has been reported (Anon, 1927) in which a farmer was fined for permitting his cow to calve in rain, hail and sleet. An appeal, on the grounds that to move her would have been more stressful - supported in court by three veterinarians - was upheld.

Edwards (1979) reported that whilst some studies (Arthur, 1961; Dufty, 1971) had suggested that the majority of cows calved by night, her own studies on 522 Friesian cows did not support this suggestion. She found that the cows calved evenly throughout the 24 hours with no bias to day or night calving. Cows calving for the third time or more however did show a significantly lower incidence of calving during milking times. Edwards concluded that this might be associated with the increased levels of activity and noise associated with milking.

For convenience of description the birth process has been divided into three stages, each stage being characterised by certain behavioural and physiological events. However as Sloss and Dufty (1980) pointed out, the stages are somewhat arbitrary subdivisions and under normal circumstances birth is a continuous process with each stage merging imperceptibly with the next. Unfortunately not all authors agree over the exact endpoint of the first stage, some suggesting that it does not include foetal entry into the birth canal whilst others consider that it does. The extent to which each stage is clinically evident and the length of time taken for its completion has been stated to vary considerably with the type or breed of cattle and the age and parity of the dam (Sloss & Dufty, 1980).

Fleming (1877) and Sloss and Dufty (1980) have described an additional stage coming before the first stage which they referred to as the preliminary or preparatory stage. The main events of the stages of labour in cattle have been set out in tabular form below (Table 4) and will be discussed individually later.

Table 4.

Main events occurring during the stages of labour in normal birth in cattle

<u>Stage</u>	<u>Main Physiological Events</u>	<u>Duration*</u>
Preparatory	Mammary development)	A few days to several weeks prepartum
	Relaxation of pelvic ligaments)	
	Lengthening of vulva)	
First	Relaxation and dilation of cervix)	4 - 24 hours
	Onset of uterine contraction)	
	Chorio-allantois enters vagina)	
Second	Uterine contraction continues)	$\frac{1}{2}$ - 3 hours
	Abdominal contractions commence)	
	Amnion enters vagina)	
	Foetus is expelled)	
Third	Loss of placental circulation)	2 - 12 hours
	Dehiscence of placenta)	
	Uterine & abdominal contractions)	
	Expulsion of placenta)	

*Times given are the average of many figures in the literature.

Detailed descriptions of the various stages of labour in cattle have been given by Fleming (1877) & Arthur (1961), Roberts (1971), Arthur (1975) and Sloss and Dufty (1980). Great variation was noted in the normal times allocated to each stage by the various authors. The greatest variation was found in figures relating to the first stage of labour. According to Arthur (1961, 1975) first stage labour was completed in 4.25 - 8.25 hours, whilst Dufty (1972) quoted a figure of 7 - 24 hours. In the view of the author of this thesis it is impossible by observation alone to be certain when first stage labour has commenced.

The Preparatory Stage

The most important changes seen in the preparatory stage are those in the udder, pelvic ligaments and vulva. Towards the end of pregnancy the authors referred to above noted that the udder became enlarged and tense and colostrum was present in the teats. The udder contents became thicker and more yellow as birth approached. In heifers especially, areas of subcutaneous oedema were sometimes seen in front of and behind the udder and might reach a depth of six inches. The vulva normally lengthens and may become slightly tumefied and oedematous although cases are not infrequently seen in which the vulva remains quite unchanged as birth approaches (Jackson, unpublished data).

The pelvic ligaments - especially the sacro-sciatic - became progressively more relaxed as parturition approached although Arthur (1961) noted that the ligaments might occasionally tighten again before once more relaxing prior to birth. The slackening of the ligaments may cause apparent elevation of the tail head and sinking of the gluteal muscles. This alteration in conformation was often referred to by 19th century authors as the cow being 'off at her hips' (Cartwright, 1845b) and was regarded as a sure sign of imminent birth. Sloss and Dufty (1980) warned that in very fat cows ligamentous relaxation might not be readily appreciated and suggested that in cases of doubt the ligaments should be palpated per rectum. Pronounced loss of tone in the cow's tail may be an indication that birth will occur within 24 hours (Wilson, J.C., personal communication).

Another sign of approaching birth is the appearance of clear mucus - not unlike the secretion observed at oestrus - at the vulva. This is believed to originate from liquefaction of the cervical mucus plug which seals the external cervical os throughout most of pregnancy. Palpation of the cervix may reveal some slight relaxation of the external os although the general tone of the cervix is unaltered (Sloss & Dufty, 1980).

Arthur (1961) stressed the importance of detecting the signs of imminent parturition so that an estimate might be made of the expected time of birth. Roberts (1971) however warned that veterinarians should refrain from making too positive or definite a statement concerning the exact time of parturition 'as subsequent events will

more than often prove him wrong'.

Other parameters have been used to detect the onset of parturition especially the drop in body temperature which sometimes precedes birth. Ewbank (1963) who studied the body temperatures of 25 parturient cattle observed that the highest temperature recorded was that two to four days prior to birth and that a definite fall in body temperature occurred before birth. He concluded 'A healthy cow showing imminent external signs of parturition is unlikely to calve in the succeeding 12 hours if its temperature is 102°F or above'. Iketaki et al. (1979) studied prepartum temperature in 68 cattle and observed that the pre-calving drop in temperature commenced 60-68 hours before calving with the most rapid drop occurring 20-32 hours before birth. Porterfield et al. (1957) using only eight cows noted that although there was a drop of 1.0-1.6°F in body temperature in five cows 24-48 hours prior to calving, the temperature of the others fluctuated so violently as to be of no value in predicting birth. A study of 44 Hereford cattle by Dufty (1971) concluded that changes in rectal temperature were unreliable guides to the onset of birth as were changes in both the mammary glands and the vulva. Relaxation of the pelvic ligaments was much more reliable an indication of approaching birth and was closely correlated with cervical relaxation. Close monitoring of rectal temperature changes would be very difficult under modern conditions of management.

Although Hindson and Turner (1966) considered prediction of the time of birth to be impossible, the author of this thesis has noticed that many experienced stockmen are apparently able to predict calving times with considerable accuracy. When questioned about the signs they look for they are often unable to say. Undoubtedly close observation of familiar animals may unconsciously reveal slight behavioural changes which represent a small but distinct departure from the normal.

When there is any doubt about whether calving is about to begin the most reliable course of action in the author's opinion is to examine the state of the cervix per vaginam and confirm that the foetus is alive and well by rectal examination.

First Stage Labour

Reviewing the duration of first stage labour quoted by a number of observers Sloss and Dufty (1980) noted figures varying from eighteen minutes to 48 hours. The first figure must be regarded as virtually impossible but the disparity is probably the result of the great difficulty of ascertaining the exact point at which first stage labour begins. The onset of uterine contractions can be detected with the aid of myometrial electrodes (Simmons et al., 1965) but these could not be used routinely.

Most observers have recorded evidence of some degree of discomfort in first stage labour in cattle. Arthur (1961) noted apprehension, cessation of eating, pawing the ground, paddling and lying down followed shortly by rising again. Fleming (1877) graphically described the cow's behaviour noting that during first stage labour she would 'suddenly stop still as if listening to some sound audible only to herself'. Straiton (1965) observed that the cow showed signs of unease and often tended to move in clockwise or anti-clockwise semicircles. Muscle tremors were also seen and both bladder and rectum were often emptied just before the birth of the calf. Straiton thought the muscle tremors he observed were a sign of pain, possibly associated with uterine contraction, but Sloss and Dufty (1980) considered that signs of discomfort were not normally seen until cervical dilation had begun.

Dilation of the cervix in cattle is believed to occur in two stages. Abusineina, cited by Arthur (1975), observed that cervical dilation commenced at the external os, this dilation being followed by a shortening of the cervix and finally dilation of the internal os. Fitzpatrick (1957) suggested a reciprocal polarity in the muscles of cervix and uterus - with uterine contractions automatically being accompanied by dilation of the cervix. Once fully dilated, the cervix is not normally recognisable on vaginal examination (Cartwright, 1845a).

The onset of cervical dilation and uterine contraction causes the chorio-allantois to be pushed into the vagina but the extent of movement is related both to the elasticity of the membranes and the tightness of placental attachment. If the chorio-allantois is not ruptured it may appear at the vulva as a bluish-coloured vascular

membrane and is known colloquially as the 'first water bag'. However Arthur (1961) noted that in 60 per cent of cattle the chorio-allantois ruptured during the first stage of labour. Rupture is followed by the escape of allantoic fluid which may give the perineum and surrounding areas a damp appearance.

Towards the end of the first stage, the foetus has been said to become more active (Arthur, 1975) and adopt the birth position and the frequency of uterine contractions increases (Schuijt & Ball, 1980). The cow may now show evidence of abdominal straining and may move about with her back arched (Arthur, 1961).

Second Stage Labour

According to Straiton (1965) the cow entering the second stage of labour ceased to behave in the 'normal' way that she did during the first stage and became somewhat 'dopey'. Straiton compared this to the state of amnesia experienced by some women during second stage labour. The second stage of birth is concerned primarily with foetal expulsion and before this can be achieved the foetus must be correctly orientated to enter the birth canal. Before considering normal foetal orientation at birth it is necessary to define the terms 'presentation', 'position' and 'posture' in the obstetrical sense. The definitions given by Benesch (1938) have been used in this thesis. They are:

Presentation - the relationship between the long axis of the foetus and the maternal birth canal. Presentation may be longitudinal (anterior or posterior), transverse or (very rarely) vertical.

Position - this term indicates that surface of the maternal birth canal to which the foetal spine is applied. Position may thus be dorsal, ventral or lateral (right or left).

Posture - the disposition of the head and limbs of the foetus. In normal birth in cattle, the foetus is in anterior longitudinal presentation, dorsal position, with the head lying upon the extended forelimbs.

Unlike the foal which was known to lie in a ventral position in late gestation the calf was believed to be in the dorsal position throughout the latter part of pregnancy (Roberts, 1971). Studies by Dufty (1973) on 52 Hereford heifers suggested that this was by no

means always the case. Dufty noted 'although changes in position took place during the last weeks of pregnancy, the foetus was most frequently found with its dorsum directed towards the ventral section of the maternal pelvis'. Marked alteration in foetal posture also occurred around this time but these changes were apparently unrelated to the time at which examinations were made or to the onset of parturition.

The calf is normally preceded by the intact amnion as it enters the birth canal and unless prior rupture occurs, the amnion appears as a greyish-white, avascular sac at the vulva. Foetal parts may be visible through the amnion which is known colloquially as the 'second water bag'. The author has encountered much confusion in the minds of farmers concerning the term 'water bag'. Many are convinced that there is only one - the amnion - because the chorio-allantois is so rarely seen. For this reason veterinary surgeons normally assume that it is the amnion to which a client is referring if he reports that 'the water bag is showing'.

Some 20 per cent of calves are born within the intact amnion (Arthur, 1959) but in the majority of cases the amnion ruptures during the second stage of labour. Once amniotic rupture has occurred the intensity of straining may increase. Abdominal straining supplements the uterine contractions and as the second stage of labour proceeds the intensity and frequency of abdominal straining increases. The cow may bellow loudly with effort. The greatest maternal effort is apparently associated with the passage of the foetal head through the vulva but at this point the foetal thorax is also entering the maternal pelvis (Schuijt & Ball, 1980; Sloss & Dufty, 1980). Once the foetal head has been delivered the rest of the calf's body usually follows with ease, although in the beef breeds, considerable effort is required to deliver the thorax and hips of the calf. Observations on the temperature, pulse and respiratory rate of the cow at calving time have shown that these parameters, perhaps not surprisingly, reach a maximum just prior to the birth of the calf. The foetal umbilical cord may remain intact following delivery if birth takes place with the cow lying down and may not rupture until the cow stands after calving.

According to Roberts (1971) approximately 95 per cent of calves

were born in anterior presentation and although calves may be born unaided in posterior presentation, Williams (1917) argued that this latter presentation might be regarded as abnormal. Roberts supported Williams' view, noting that not only was there increased friction from the calf's hair in posterior presentation but more space was needed for the hind limbs to become correctly orientated.

Not surprisingly considerable biochemical changes occur in the blood of the parturient cow. Sloss and Dufty (1980) found that whilst potassium and copper levels tended to rise, calcium, zinc and on occasion magnesium and inorganic phosphate levels fell. Bostedt (1974) also recorded low levels of calcium and inorganic phosphate during both normal birth and dystocia. The return to normal levels was considerably slower after cases of dystocia. An elevation in blood lactic acid, probably the result of intense muscular activity, has also been reported (Graf & Petersen, 1953).

Changes in the cellular composition of the cow's blood have also been observed - possibly the result of stress. Kerr et al. (1951), Arthur (1961) and Sloss and Dufty (1980) all found evidence of a lymphopenia and a neutrophilia. Szepeshelyi (1935) found that unless septicaemia occurred, the changes in composition of the cow's blood following dystocia were similar to those following normal birth.

The physiological changes undergone by the calf at birth are enormous (Drost, 1980b). Brunson (1981) has reviewed the great differences to be found in the foetal heart and lungs before and after birth. Some degree of acidosis has been observed in all calves at birth (Moore, 1969) but this is normally resolved within one hour of delivery. During birth, Too et al. (1965, 1967), using foetal electrocardiograms, noted a fall in foetal heart rate following amniotic rupture, with a marked rise occurring immediately post-partum.

Third Stage Labour

Arthur (1975) has suggested that placental separation followed dehiscence of the membranes and a fall of capillary blood pressure within them. Uterine and some abdominal contractions normally expel the placenta within twelve hours of birth. Retention beyond twelve hours is usually prolonged by a further period of retention lasting

at least three to four days. Recent studies at Utrecht have demonstrated a massive accumulation of polymorph leucocytes at the sites of placental attachment to the uterus following the birth of the foetus. The presence of the leucocytes, which are only found in small numbers in cases of placental retention, may indicate that the foetal membranes are treated by the uterus as a foreign body once foetal delivery is complete (de Bois, personal communication).

Interference in Normal Birth

Wherever possible the cow should be left to calve unaided. Skellett (1807) wisely advised 'this plan which nature herself dictates should be allowed on all occasions to take place and no interference ever made unless absolutely necessary'. Simonds (1849) counselled against premature interference as did Roberts (1971) and many others. Great variation occurs in the duration of the various stages of labour and in heifers the early stages may be much longer than in the cow. Breed variation has also been observed. O'Mary and Hillers (1976) studied calving time and other parameters in Aberdeen Angus heifers served with either Angus or Charolais bulls. All stages of birth were longer for the Charolais sired calves, which required an average of 43.9 minutes for second stage labour compared with 30 minutes for the Angus sired calves. Both breed and sire effect may have exerted influence in this case. The weight of the calf is also important and O'Mary and Coonrad (1972) found that second stage labour for a calf weighing 37.4 Kg required 47 minutes whereas for a calf weighing 31.6 Kg it only required 29.7 minutes.

An important observation made by O'Mary and Hillers (1976) was that the time taken from the appearance of the amnion to the appearance of the calf's fore-feet was a good indication of what total calving time would be.

Despite the warnings of the dangers of premature intervention, the author of this thesis believes that delay is equally if not more dangerous. Drost (1980a) advised that clients should be educated in the supervision of calving. Any departure from the normal should be reported. Vaginal examination should be carried out in cases where the start or progress of first stage labour is uncertain. Once the amnion appears in second stage labour the calf should normally be

born within two hours (Arthur, 1961; Young, 1968b; Schuijt & Ball, 1980; Sloss & Dufty, 1980). Although the foetus can remain alive in utero for up to ten hours (Schuijt & Ball, 1980) death can occur much earlier than this (Young, 1968b) once second stage labour is underway. Experiments by Dufty and Sloss (1977) involving ligation of the foetal umbilical cord in utero, established that whilst four of six calves survived anoxia lasting up to four minutes, none survived anoxia lasting more than six minutes.

Whenever satisfactory progress is not being made in a case, the cow should be examined with a view to assisted delivery.

Illustrated Account of Normal Bovine Parturition

The following account describes the first stage and especially the second stages of labour in a thirteen-year-old Ayrshire cow 'Quaker Girl' delivering her tenth calf at the Cambridge Veterinary School (Plates 1-10).

PLATE 1

Normal birth (i) Late first stage labour. The cow is restless and the chorio-allantois has ruptured.

PLATE 2

Normal birth (ii) Early second stage labour. The amnion is clearly visible and still intact.

PLATE 3

Normal birth (iii) Early second stage labour. The amnion is intact but vulnerable. Straining is intense.

PLATE 4

Normal birth (iv) The amnion has ruptured although remnants are still visible. The cow is straining vigorously and the foetal fore-feet are just emerging through the vulval lips.

PLATE 5

Normal birth (v) Second stage labour is fully underway. Straining is intense and the foetal tongue and muzzle are now visible at the vulva

PLATE 6

Normal birth (vi) The foetal muzzle is now clearly visible and the cow is resting briefly between bouts of straining.

PLATE 7

Normal birth (vii) Delivery of the foetal head is complete. The position of the calf is approximately 45° from the dorsal position, allowing the calf to take advantage of the greatest diameter of the maternal pelvis. The foetal tongue is protruding as it often does at this stage of delivery.

PLATE 8

Normal birth (viii) The foetal head and shoulders have now been delivered. The calf lies still but if the umbilical cord becomes compressed the calf may move vigorously and breathing may commence.

PLATE 9

Normal birth (ix) Delivery of the calf is now complete but the umbilical cord is at the moment still intact.

PLATE 10

Normal birth (x) The cow has risen and is licking the calf commencing, as usual, at the head. The time elapsing between Plates 1 and 10 was approximately two hours.

CHAPTER FOUR

THE INCIDENCE OF BOVINE DYSTOCIA

There are few references to the incidence of bovine dystocia in the early literature and it is only in the last twenty years that surveys involving significant numbers of farms and animals have been carried out. It has however long been recognised that dystocia occurs more frequently in the cow than in the mare. As Fleming (1877) noted 'every practitioner who has had any experience in this matter will testify that for one case in the mare or other animal there will be at least ten cases in the cow'. Anderson (1926) and other authors have agreed with this view. Williams (1931) suggested that the overall incidence of bovine dystocia might be in the region of 3.3 per cent of all calvings and considered that the problem was more serious in dairy than beef cows.

Practitioners in cattle breeding areas spend much of their time attending cases of dystocia. In a survey of the work of twelve American Veterinary School clinics, Davis and Frandson (1954) noted that attendance at dystocia cases accounted for 2.3 per cent of the case load. Grunsell and Paver (1955) who reviewed the work of three British practices found that bovine obstetrical work accounted for 6.2 per cent of all conditions treated. More recently Armstrong et al. (1978) have suggested that dystocia cases can account for 20-25 per cent of the case load in bovine practice.

In recent years many more surveys of the incidence of bovine dystocia have taken place and the author has encountered over eighty references to the subject published since 1955, the majority since 1970. There are a number of reasons for the apparent interest of authors in this subject. Much of the early literature consisted of anecdotal accounts of single dystocia cases and it was only in relatively recent years that the need for comparison was appreciated. Communication of information has improved as have methods for statistical analysis of collected material. Undoubtedly the incidence of dystocia has increased and in times of economic difficulty its

importance as a source of economic loss has been identified and has stressed the need for further study. In this chapter, the author will attempt to analyse the various studies of the incidence of dystocia and to comment upon the factors which may influence the occurrence of dystocia.

The results of studies of the incidence of bovine dystocia must be interpreted with care since the definition of 'dystocia' is likely to be subjective. The distinction between eutocia and dystocia can be difficult to define and in cases where premature interference with normal calving cases has occurred the apparent incidence of dystocia may be excessively high. Tong et al. (1976), Wythes et al. (1976), Hartigan (1979) and Dufty (1981) have all warned of the dangers of excessive supervision of parturient cattle which may encourage unnecessary interference and the assumption that dystocia is present when in fact it is not. In some surveys (including those of Anon (1960); Sloss (1974a); Pollak (1975); Kilkenny and Stollard (1976); Philipsson (1976); Cady et al. (1979); Stables (1979); Thompson (1980)) the raw data has been compiled by farmers who were in some cases asked to classify the severity of dystocia encountered. Such 'farmer-compiled' surveys are open to other inaccuracies in addition to that of misinterpretation of a normal calving case. Some farmers may not wish to reveal the extent of the problem they are experiencing whilst others may regard dystocia cases as of little importance. Ideally, as Sloss and Dufty (1980) have pointed out, the best surveys would be those compiled from personal experience by the clinician attending a farm. Such surveys would only be able to cover a relatively few farms and thus fail to give an overall picture. Despite the various shortcomings, surveys are important and have made it possible to identify and in some cases to quantify the various factors involved in the incidence of dystocia. Comparison of figures may be more valid within surveys than between different surveys but reasonable conclusions can be reached when similar trends are shown.

In almost all surveys the importance of disparity between the size of the calf and the pelvic inlet of the dam has been emphasised. Small profit margins in cattle production have led to attempts to improve the quality of calves born in terms of greater birth weight, carcase quality and growth potential. Unfortunately such 'improvements'

contribute in many cases to an increased incidence of dystocia. Méniessier and Foulley (1979) reviewing the incidence of dystocia in European cattle commented 'In the suckler cow population of the British Isles, the passage from small-sized breeds with a high calving ability to populations of larger sized (continental beef) breeds leads to an increase in the weight of calves and to a substantial rise in the frequency of dystocia. This incidence is generally further increased by a more intensive management of these populations of suckler cows as compared with local breeds'. Another survey carried out by Smidt and Huth (1979) suggested that Britain was by no means alone in experiencing an increase in calving problems.

A number of surveys have attempted to quantify the incidence of dystocia in cattle and others have attempted to identify the factors which may contribute to it.

The Overall Incidence of Bovine Dystocia

The suggestion by Williams (1931) that dystocia might occur in 3.3 per cent of calving cases was based on a survey of European cattle made in 1921. The survey involved nearly 500,000 calvings and was possibly a good indication of the true incidence of dystocia. Withers (1955) found 1.6-2.0 per cent dystocia in a pilot survey of 120 dairy herds in Britain and in a more extensive survey (Withers, 1959) involving 110 herds he found a dystocia rate of 1.5 per cent. In a smaller survey of five herds, Wright (1958) recorded dystocia in 4.5 per cent of all calvings. Reviewing the world literature, Sloss and Dufty (1980) noted a considerable disparity in published figures which covered the range 0.8-27 per cent. Undoubtedly in some cases the incidence of dystocia is much higher than the published figures would suggest. In Belgium dystocia may occur in up to 80 per cent of Blue-White heifers (Hanset & Jandrain, 1979; Ectors, personal communication), whilst in a well-managed Friesian-Holstein herd near Cambridge up to 50 per cent dystocia has been recorded in cows and up to 83 per cent in heifers (Edwards, personal communication). In the latter case there is evidence that there may have been some premature interference with normal calving cases. Other authors have described individual farm problems where dystocia has reached unacceptable levels. Plenderleith (1974) encountered 57 per cent dystocia among

seven heifers in calf to a Charolais bull and he managed successfully to reduce the incidence of dystocia in other heifers on the same farm by strategic induction of birth. It has been suggested that some herds may have an inherently high level of dystocia. Strachan et al. (1980), working in Australia, compared heifers taken from a herd where there was a high level of dystocia (45 per cent for the years 1971-5) with heifers from a farm where dystocia was much lower (6 per cent for the years 1971-5). The heifers were managed and housed together and parturient success was compared. The incidence of dystocia was 40.5 per cent and 21.4 per cent respectively in heifers from the high and low dystocia herds. Numerous measurements were made, including calf weight and maternal pelvic size but the differences observed by the authors were not sufficient to account for the apparent herd variation in the incidence of dystocia. It is not clear why the level of dystocia in the 'low dystocia herd' should have risen from 6 to 21.4 per cent.

Factors Influencing the Incidence of Bovine Dystocia

It is perhaps iniquitous to separate the various factors which may contribute towards a particular case of dystocia since in most cases a number of factors are involved. The danger of investigating the role of individual factors should not, however, be over-emphasised since each does make a contribution and by quantifying and hopefully modifying its influence, some progress may be made in the quest for a reduced incidence of dystocia.

The factors influencing the incidence of bovine dystocia may be conveniently divided into two groups, those involving the environment of the animals and those which contribute to the genotype of the animals concerned. Environmental factors include the management and diet of the pregnant cow whilst the genotypic factors include the breed of the sire, size and weight of the calf, the pelvic diameter of the dam and many other important details.

Environmental Factors influencing the Incidence of Dystocia

a) Season of the Year

Both Lindhe (1966) and Pollak (1975) noted that the incidence of dystocia varied with the season of the year but gave no details. In

his survey Stables (1979) observed that the weight of calves at birth increased during the summer months and suggested that this might give rise to higher levels of dystocia than at other times of the year. Young (1968b, 1970) reported that the mean birth weight of calves increased by 1.4 lbs for every ten days progression during the calving season as maternal diet improved. In contrast to the above reports, Philipsson (1976) working with Swedish cattle found that the incidence of dystocia increased during the winter months. He considered that the greater exercise available to parturient cattle in the spring and summer was beneficial to the cows' general fitness including the ability to give birth unaided.

b) Supervision

Some supervision is essential at calving time but it is important that it is carried out discreetly by experienced observers who are familiar with normal birth. Premature interference can result in disturbance of the normal birth process which may either give rise to falsely high levels of reported dystocia or actually cause dystocia. Both Greene (1981) who was investigating the use of clenbuterol to suppress myometrial activity and Hartigan (1979) who was working with a herd of Charolais heifers reported an incidence of dystocia of over 80 per cent which they attributed to premature interference by inexperienced stockmen.

Some degree of confinement of cattle may be necessary for effective supervision and management of parturient cattle but Dufty (1981) recorded a five-fold increase in the incidence of dystocia in animals confined just prior to birth. Although the incidence of assisted births was higher in these herds, the incidence of stillbirth was lower perhaps suggesting that no serious damage was done by the close supervision of these animals. Wythes et al. (1976) noted a high incidence of dystocia in herds where owners had been concerned with earlier losses and through anxiety were reporting dystocia where none existed. It must be noted that supervision of birth is a costly procedure and Lowman (1979) considered that it could only be justified economically when the calving season was short.

c) Diet

Adequate diet is essential for good reproductive performance including parturition. Corah et al. (1975) carried out feeding trials

in beef cattle over the last 100 days of gestation to assess the importance of energy levels to both dam and foetus. Although they found that calf survival was reduced in those animals receiving low energy diet there was no difference in the incidence of dystocia in high or low energy groups. Maternal diet can exert an influence on calf weight and hence dystocia (Young, 1970) but Laster (1974) found that although pre-calving energy levels influenced calf weight they had no influence on the incidence of dystocia.

Intentional restriction of maternal diet is practised by some farmers in an attempt to reduce the problem of foetal oversize but the author (Jackson, unpublished case records) and Tudor (1972) have encountered problems of maternal debility and uterine inertia where such restriction of diet has been excessively used. In a recent report Doxey and Scott (1983) encountered serious maternal loss through liver damage and mycotoxicosis in pregnant cows which had undergone a dramatic reduction in the quality of their food.

Grünert (1979) observed that pelvic size, calf size and maternal pelvis relaxation might be reduced in underfed heifers. Extremely overfed animals might suffer high calf mortality and prolonged parturition through an excessive deposition of fat in the pelvic region. Lowman (1979) warned that 'starvation diets' given to beef cattle in an attempt to reduce foetal size might result in poor lactational performance and reduced calf viability.

d) Disease

Any debilitating condition preventing the animal from accomplishing normal birth may lead to an increase in the incidence of dystocia. Farms on which hypocalcaemia is a problem may also experience a high incidence of dystocia due to uterine inertia. Specific diseases such as brucellosis and salmonellosis have been reported as affecting the incidence of dystocia. Mitchell (1939) noted that the incidence of dystocia fell dramatically in herds once brucellosis eradication had been achieved. Richardson (1973) suggested that cows infected with *Salmonella dublin* might be more prone to calving difficulties. In one herd he recorded 21 per cent of cows requiring assistance at calving compared with what he considered to be a normal level of 1.8 per cent.

e) Induction of Birth

Induction of birth at or before term is one of the methods employed to reduce the problem of foetal oversize as a cause of dystocia. The drugs used and the success of induction will be discussed later. Many authors including Plenderleith (1974), Carter and Parsonson (1976) and Terblanche et al. (1976) have reported a reduction in the incidence of dystocia following induction of birth, but Barth et al. (1978) found no difference between treated animals and controls. Unfortunately induction of birth is not always successful in reducing the incidence of dystocia. In a small group of animals in which birth was induced to avoid foetal oversize the author (Jackson, 1979) recorded 75 per cent dystocia due to foetal malpresentation. Working in New Zealand with prostaglandin F_{2α} Day (1979) encountered dystocia due to failure of the cervix to dilate in 72 per cent of induced heifers.

Johnson and Jackson (1982) considered that the incidence of dystocia was greater the earlier in gestation that parturition was induced.

Factors Related to Genotype influencing the Incidence of Dystocia

There are a number of factors within this category many of which are inter-related. The weight of the calf has an important influence on the incidence of dystocia and is itself influenced by various factors which will be discussed below.

a) Age of Dam

In most management systems the age of the dam is closely related to her parity but in a number of studies age has been shown to influence the incidence of dystocia. In a study of dystocia in Friesian heifers (Anon, 1973) it was found that heifers calving at under 1.75 years or over three years of age suffered more calving difficulty than those which calved between two and three years of age. 28.6 per cent dystocia was encountered in those calving at under 1.75 years and 33.3 per cent dystocia in those calving at over 3.25 years whilst those calving between 2.25 and 2.5 years suffered only 9.8 per cent dystocia.

Jackson (1963), working with heifers in America, criticised the practice of breeding from immature animals. He found that the

incidence of dystocia in heifers calving at 2 years of age might be 10-40 per cent higher than in those calving at $2\frac{1}{2}$ years.

b) Parity of Dam

A survey of 2035 births in cattle in the ABRO herd in Staffordshire by Donald (1963) revealed that dystocia in heifers occurred twice as frequently as it did in cows and Lindhé (1966) who reviewed the work of a number of authors agreed with this view. In a survey of 200 cases of dystocia Williams (1967, 1968) noted that 35.5 per cent of his cases were in heifers whilst 64.5 per cent were in older cows. He considered his results to prove a higher incidence of dystocia in heifers than in cows when he took account of their relative numbers in the National herd. Sloss and Dufty (1980) suggested that heifers were exposed to at least three times as much dystocia as were pluriparous cows. Induced birth in heifers is also likely to be associated with higher levels of dystocia than induced birth in cows (Day, 1979).

The tendency of the incidence of dystocia to fall with increasing parity was demonstrated by Edwards (1979) who worked with a Friesian herd in which she recorded dystocia levels of 66.5 per cent, 23.1 per cent and 14.3 per cent in animals of first, second and third parity respectively.

c) Breed

A number of surveys have been conducted into the incidence of dystocia in the various breeds of cattle. A summary of the findings of these surveys is given in table form below (Table 5). Considerable variation will be noted for some breeds especially the Friesian. The survey which Allen (1976) reported was based on a Meat & Livestock Commission review of 19,000 calvings in 800 beef herds. In this survey the lowest level of dystocia (2.4 per cent) was seen in Aberdeen Angus herds and the highest (9.0 per cent) in Charolais herds. The Charolais has a very poor reputation from the viewpoint of ease of calving and for this reason will be considered at greater length below.

Table 5

The Incidence of Dystocia in Pure Breeds of Cattle

<u>Breed of Cattle</u>	<u>Incidence of Dystocia</u> %	<u>Source of Data*</u>
Aberdeen Angus	2.4-17.0	3,5,6,8.
Ayrshire	2.5- 8.5	1,7,8.
Charolais	9.0-17.3	2,6,8.
Friesian	4.7-40.0	1,4,7,8,9.
Hereford	8.8-30.1	2,5,6,8.
Jersey	0.0- 5.4	7,8.
Limousin	7.4	6.
Simmental	8.9-12.1	6,8.
South Devon	8.7	6.

*

1. Anon. (1960)
2. Lindhé (1966)
3. Sagebiel et al. (1969)
4. Anon. (1973)
5. Laster et al. (1973)
6. Allen (1976)
7. Smidt and Huth (1979)
8. Sloss and Dufty (1980)
9. Edwards (personal communication)

The breed of cattle has also been shown to exert an influence on the incidence of dystocia in crossbreeding. Laster et al. (1973) analysed the records of 1889 Hereford and Aberdeen Angus females bred to a variety of bulls including Jersey, Simmental and Charolais animals. Hereford cows bred to these breeds encountered 11.37 per cent, 34.8 per cent and 42.03 per cent dystocia respectively. Pure bred Herefords in the same survey suffered 18.6 per cent dystocia. The influence of Charolais bulls and of certain sires within a breed will be discussed below.

The survey by Donald (1963) found that Friesian and Hereford bulls sired more calves in dystocia cases than did Jersey or Ayrshire bulls. Nelson and Huber (1971), working with Hereford heifers and cows found that Hereford sired calves suffered 15 per cent dystocia whilst calves sired by a Swiss bull suffered 28 per cent dystocia. In another survey (Liboriussen, 1979) the incidence of dystocia in Danish domestic breeds of cattle was compared between sires of various breeds. 7.5 per cent, 51.3 per cent and 53.7 per cent difficult calvings respectively were reported when Angus, Charolais and Romagnola sires were used.

d) The Sire of the Calf

The influence of breed on the incidence of dystocia has been discussed above and it has been noted that this influence may be evident in both pure and cross breeding. A number of authors have suggested that certain sires within a breed may have an influence on the incidence of dystocia which cannot be satisfactorily explained except by suggesting that in some cases a 'sire effect' may be of importance. Plenderleith (1974), quoting Milk Marketing Board data relating to three Simmental bulls, noted that the level of dystocia in calves they had sired was 1.3 per cent, 6.7 per cent and 7.5 per cent respectively. Lindhé (1966) and Stables (1979) had also remarked upon this 'sire effect'. Thompson (1980) who surveyed the records of 177,455 calvings emphasised the need for monitoring the ease of delivery of calves produced by every bull so that evaluation for 'sire effect' might take place. Earlier work by Pollak (1975) had also noted the influence of the sire upon the level of dystocia and had also considered the influence of grandsires. Pollak concluded 'The rank correlation between estimates of sire breeding values as sires and grandsires was not significantly different from zero, reducing the concern of compounding dystocia problems through recommended matings'. The low heritability of dystocia was also discussed by Tong et al. (1976) who despite this suggested that as many calvings as possible from the progeny of each bull should be monitored giving a 'roll on' assessment of calving ability.

Cady et al. (1979) suggested that evaluation might also be made of maternal grandsires and their influence on the incidence of

dystocia even though this might be low. Later Cady (1980), perhaps sagely, pointed out that for some of the analyses he advised 'much computer time would be needed' and that 'the costs may outweigh the returns'.

In some cases it may be possible to relate the 'sire effect' to a more tangible factor affecting dystocia levels. Some sires have been found to sire calves with an abnormally long gestation period and hence a tendency to foetal oversize. Price and Wiltbank (1978a) found that the calves of sires with a higher than average incidence of dystocia were larger for all measures of body size. Osinga (1978) and Osinga and Hazeleger (1979) suggested that the sire effect might be mediated by the output of oestrogens from the foeto-placental unit in late gestation. Low output being associated with poor dilation of the maternal birth canal.

e) The Charolais

This breed has possibly the worst reputation of any breed for a high level of dystocia and for this reason is worthy of special mention. The superb lean meat qualities of the breed (Ménissier et al., 1981b) have undoubtedly contributed to its popularity. The frequency with which dystocia occurs has in the opinion of Ménissier et al. (1981a) acted as a curb to its wider distribution. Despite the reputation for dystocia the enhanced value of any living calves produced may encourage farmers to take a risk (Grunsell et al., 1967).

Shortly after its introduction into Britain, much concern was voiced about the high level of dystocia reported when the Charolais was used for cross breeding on native cattle. A survey conducted by the Veterinary Clinical Observation Unit (Anon., 1963) recognised the problem and advised that until more facts were known the Charolais should not be used on heifers. Lindhé (1966) noted that cross-breeding with Charolais bulls often produced higher levels of dystocia than were seen in pure-bred Charolais. Hansen (1966) recorded 14 per cent dystocia in Jersey heifers served with a Charolais bull although Arthur (1966) considered that such breeding did not always result in this level of dystocia.

There are many other reports of the adverse effect of the Charolais in cross-breeding. Smith et al. (1973) reported that

whilst pure bred Kerry cattle had an almost zero level of dystocia, 40 per cent dystocia was observed when Charolais bulls were used. A similar finding was reported by Sagebiel et al. (1969) who found that the incidence of dystocia in Aberdeen Angus cattle rose from 11 per cent to 58 per cent when Charolais bulls were used for cross-ing. In Scandinavia and Germany Ménissier and Foulley (1979) found that the Charolais increased dystocia in indigenous cattle by 10-14 per cent, whilst in Australia Stephenson and Gates (1973) noted an increase in dystocia from 4.1 to 8.3 per cent when Charolais semen was used in native cows.

In some studies however the Charolais does not appear in quite such a poor light. Singleton et al. (1973) found that the use of Charolais bulls on Hereford heifers resulted in less dystocia than was observed in those served by a Hereford bull. It is interesting to note that when used for cross-breeding the Charolais cow is not normally associated with high levels of dystocia (Sagebiel et al., 1969).

The reason for the poor calving ability of the Charolais has been described by Ménissier et al. (1981c) as being due to 'a morphological disequilibrium between the large size of the calf and the relatively poor development of the pelvic opening in the mother'. These authors suggested that in future selection procedures should be employed which would allow a 'reasonable compromise between meat production and breeding quality in the Charolais breed'.

f) Dam weight and size

Although Price and Wiltbank (1978b) considered that the weight of the dam had a low and insignificant correlation with the incidence of dystocia, a number of authors have suggested that the higher the weight of the dam at parturition, the lower the incidence of dystocia. Cadle and Ruttle (1976) working with range beef heifers found that dam weight was negatively correlated with dystocia whilst Singleton et al. (1973), also working with heifers, found that the 'dystocia score' (range 1-6) fell by 0.68 for each increase of 45.4 Kg of dam body weight.

In a study of 458 calvings of cattle of various breeds, Monteiro (1969) suggested that dam weight and calf weight were mathematically related to the incidence of dystocia. He suggested the following relationship:-



Index of dystocia = $\log \text{Calf weight} - 0.4 \log \text{Dam weight} - 0.1 P$
 (where $P = 0$ for first parity and $P=1$ for second parity calvings).
 One major disadvantage of this formula is that it can only be used retrospectively since the calf's weight cannot be accurately assessed before calving.

Although Ward (1973) considered that body measurements of the dam were not correlated with the incidence of dystocia, other authors have not agreed. Webster (1977) found that heifers requiring no assistance at parturition were on average taller at the withers, slightly heavier and had significantly larger pelvic areas than those requiring assistance. Cadle and Ruttle (1976) reported that they found less dystocia in what they described as 'large-framed' dams. Young (1970) noted a significant relationship between dam weight and pelvic size, heavier animals having larger pelvic areas than lighter animals.

g) Pelvic Size of the Dam

It has been suggested that the pelvic size of the dam and the birth weight of the calf are the two most important factors affecting the incidence of dystocia (Bellows et al., 1971b; Price and Wiltbank, 1978a; Short et al., 1979). The most restricting part of the pelvis is the inlet or anterior entrance which is the only part to be wholly encircled by bone. The inlet is formed dorsally by the base of the sacrum, laterally by the medial surface of the shaft of each ilium and ventrally by the body of the pubis. A number of authors have commented on the relationship between pelvic size and the incidence of dystocia. Young (1970) found that the pelvic size of heifers suffering dystocia was smaller than that of heifers calving normally. Similar findings were reported by Webster (1977). Laster (1974) observed that larger heifers normally had larger pelvic inlets but warned that such heifers often had larger calves which might nullify the advantages of the larger pelvic opening.

Pelvic size varies with different breeds of cattle and there is also considerable variation within the breed (Laster, 1974). The relatively small vertical diameter of the Friesian pelvis has been noted by Stables (1979) whilst M  nissier (1980) considered the pelvic opening of the Charolais to be poorly developed - this latter

problem being exacerbated by double muscled Charolais calves. A further problem involving double muscled animals in the Belgian Blue-White breed was reported by Hanset and Jandrain (1979) who observed that the pelvic height of double muscled cows was significantly smaller than in normal animals. Pelvic height was considered by Singleton et al. (1973) to be particularly important as a measure of ease of calving. Webster (1977) noting that Aberdeen Angus heifers with small pelves were particularly prone to dystocia recommended that such animals should not be used for breeding. Pelvic area is normally expressed in square centimetres (cm^2). Since the pelvic inlet in cattle is approximately rectangular in shape, Rice and Wiltbank (1972) suggested that it might legitimately be measured as the product of the dorso-ventral and lateral diameters. Measurements of cattle taken by Ward (1971, 1973) confirmed that pelvic area was indeed closely related to both of the diameters.

Specific pelvic areas in relation to the incidence of dystocia have been discussed by a number of authors. Rice and Wiltbank (1972), working with Hereford heifers, found that animals with a pelvic area of less than 200 cm^2 suffered 69 per cent dystocia whilst those with a pelvic area greater than 200 cm^2 suffered 23 per cent dystocia. Ward (1971, 1973) reported that Aberdeen Angus x Hereford heifers with a pelvic size of less than 225 cm^2 experienced 50 per cent dystocia.

Pelvic size has been found to increase with age and Singleton et al. (1973), in a study of 74 heifers, noted that the mean pelvic area of these animals increased from 199 cm^2 at 413 days of age to 291 cm^2 at 702 days. Diet can also influence pelvic size in the growing animal and both Young (1970) and Laster (1974) found that heifers on a poor quality diet had significantly smaller pelves than those receiving adequate diet.

Internal pelvic measurements require the use of a pelvimeter and some difficulty may be experienced in obtaining accurate measurements. For this reason, some workers have attempted to correlate external measurements with internal measurements. Ward (1971, 1973) and Cadle and Ruttle (1976) were among authors who found a close correlation between the internal pelvic measurements and the external distance between the tubera coxae. Working in

Israel, Ben David (1980) devised a formula relating the inter-tubera coxae diameter (DTC) to the circumference of the birth canal (CBC):-

$$CMC = 20.2 + 0.9 \times DTC$$

The DTC figure, easily measured, was found to be most useful to predict the likelihood of dystocia. Animals with a DTC of less than 36 cm were likely to suffer a high frequency of dystocia whilst those with a DTC of over 40 cm were likely to calve without difficulty.

h) Weight and Size of the Calf

Calf birth weight has a major effect on the incidence of dystocia. Many authors have noted an increase in the rate of dystocia with increasing calf weight (Bogner et al., 1970; Pattulo, 1973; Ward, 1973; Pollak, 1975; Kilkenny and Stollard, 1976; Webster, 1980). Attempts to improve calf quality have often been associated with increased birth weight and dystocia (Ménissier and Foulley, 1979; Ménissier, 1980; Thompson, 1980).

Laster et al. (1973) in a study of beef cattle found that the incidence of dystocia rose by 2.3 per cent for each 1 kg increase in calf birth weight. Smith et al. (1973) considered that there might be a similar linear relationship between calf weight and rate of dystocia. They found that each 1 kg increase in calf weight was associated with a 1.63 per cent increase in the rate of dystocia. Working with Hereford cattle Rice and Wiltbank (1972) found that calves suffering dystocia were on average 2 kg heavier than those born without aid. A review of 50,000 calvings by Kilkenny and Stollard (1976) concluded that calves suffering dystocia were 3.5 kg heavier on average than those born normally.

Calf birth weight cannot be considered in total isolation since its ability to influence dystocia is closely related to the pelvic size of the dam. Young (1970) found that heifers suffering dystocia had calves 7 lbs heavier and had pelvic areas 15.5 cm² smaller than those of heifers calving normally.

Other factors affect calf weight and Laster (1974) considered the most important of these to be genotype, gestation length, sex of the calf and age of the dam. Breed has a marked effect on calf weight in both pure-bred and crossbred animals. Allen (1976) in his survey of 19,000 beef cattle calvings found birth weight highest in Charolais which suffered 9 per cent dystocia and lowest in Aberdeen

Angus cattle where the incidence of dystocia was only 2 per cent. The special problems of the parturient Charolais have been discussed above, but in the context of crossbreeding, Hansen (1966) found that when Charolais bulls were used on Jersey cows, the mean male calf weight was 86 lbs compared with 48.5 lbs for the purebred Jersey calf. The effect of Charolais bulls on calf birth weight was also noted by Smith et al. (1973) working with Kerry cattle. Nelson and Huber (1971) found that Hereford dams served by Charolais or Swiss bulls produced heavier calves and suffered more dystocia than those served by Hereford bulls. The importance of breed in relation to calf weight was also emphasised by Stables (1979) who noted that Friesian cattle sired by Friesian bulls produced calves of a mean birth weight of 88.9 lbs whilst those served by Charolais bulls produced calves weighing an average of 101.7 lbs.

Bellows et al. (1971a) found that dam weight and calf weight were closely related. Arthur (1975) reported that the ratio of calf weight to dam weight was 1:12 in Friesian cattle and 1:14 in Jersey cattle and suggested that this might be one reason why the incidence of dystocia was lower in Jerseys than in Friesians. The plane of the dam's nutrition was found by Young (1970) to influence calf birth weight. Cows on a high plane of nutrition produced calves 5.5 lbs heavier than those on a low plane of nutrition. Tudor (1972) reported similar findings. Laster (1974) agreed that better nutrition often resulted in higher birth weight but did not consider that this necessarily resulted in a higher incidence of dystocia.

A seasonal increase in calf weight was noted by Young (1970) and by Stables (1979) which was probably associated with better grazing. The sex of the calf has an influence on calf birth weight and hence on the incidence of dystocia (Philipsson, 1976). A number of authors including Anderson and Bellows (1967), Bellows et al. (1969) and Huber and Nelson (1971) reported that male calves were heavier than females.

The shape of the calf is not necessarily related to its weight (Laster, 1974), but a heavy calf normally has large dimensions in all respects and Price and Wiltbank (1978a) considered weight to be an important measure of calf size. Laster (1974) noted that similar levels of dystocia might be seen in herds of different breeds where

calf weight was not identical. He concluded that calf shape might well be an important factor affecting the incidence of dystocia. In a small survey of heifers in New Mexico, Cadle and Ruttle (1976) found that the width of the calf's head was closely correlated to the incidence of dystocia. Stables (1979) considered that the Friesian calf, when compared with other breeds had a greater depth from spinal column to sternum at the level of the first rib. Skeletal measurements were considered to be more heritable than birth weight by Price and Wiltbank (1978b).

The abnormal dimensions of double muscled calves are particularly likely to be associated with a high incidence of dystocia, the large muscle masses of shoulder and thigh contributing to foeto-pelvic disproportion (Ménissier, 1980). Double muscling occurs in a number of breeds including the Charolais (Ménissier and Foulley, 1979), Red West Flemish (Vandenbussche et al., 1964) and the Belgian Blue-White (Ménissier and Foulley, 1979; Ectors, personal communication).

i) Sex of the Calf

Farmers have traditionally associated male calves with a high incidence of dystocia and a number of surveys have confirmed this view (Anon., 1963; Young, 1968b; Bellows et al., 1969; Pollak, 1975). Sloss and Dufty (1980) suggested that a higher incidence of dystocia involving male calves might be seen in primiparous heifers. Anderson and Bellows (1967) found that more male than female calves required assistance at birth and those which died during parturition showed signs of injury due to prolonged parturition. Bellows et al. (1971a) noted that male calves had a higher calving score than female calves and Lindhé (1966) considered that dystocia was 1.5-2.5 per cent more frequent in male calves. Similar findings were recorded by O'Brien and Stott (1977) in a study of Holstein heifers. The incidence of dystocia was 33 per cent in male calf births compared with 17 per cent in heifer calf births. An interesting exception to the higher rate of dystocia associated with male calves was found by Stables (1979) in South Devon heifers. In a small survey male calves were associated with 4.17 per cent dystocia whilst female calves suffered 6.98 per cent dystocia. When cow calvings were considered however male-calf dystocia predominated.

Philipsson (1976) was one of a number of authors who considered that the main influence of calf sex on the incidence of dystocia was associated with the greater weight of male calves.

j) Gestation Length

Calf birth weight and gestation length are closely related (Bogner et al., 1970; Bellows et al., 1971a; Stables, 1979). The growth of the foetus is rapid during late gestation and Arthur et al. (1982) have estimated that in some breeds foetal weight may increase by as much as 0.5 kg per day in the last few weeks of pregnancy. Stables (1979) listed a number of British breeds in order of their mean gestation length and compared these figures with those of calf body weight. The shortest gestation length (281 days) was seen in the Friesian in which calf birth weight was lowest. However at the other end of the scale, gestation length was longest (287 days) in the Limousin which did not have the highest calf weight. Jersey, Ayrshire and Aberdeen Angus cattle were not included in this survey. In an early review of the performance of the Charolais breed (Anon., 1963) it was observed that gestation length in this breed was 'one week longer than normal', with 75 per cent of gestations exceeding 287 days.

Male calves may experience a slightly longer gestation than female calves but Hansen (1966) working with Jersey cattle and Hartigan (1979) working with crossbred Charolais cattle found no difference in gestation length between male and female calves.

Weight is not the only dimension which may increase with gestation length. As Rosenberger (1979) observed the long bones of the foetus grow quite rapidly in late gestation possibly predisposing to malpresentation should pregnancy be excessively prolonged.

A number of authors have suggested that gestation length of calves sired by particular bulls may be longer than normal. Knapp et al. (1940) considered that there was a tendency for individual cows to have a characteristic length of gestation.

k) Other Factors

There are a number of other factors which, although less well documented, may affect the incidence of dystocia. Twinning is often associated with a higher incidence of dystocia than singleton birth and among twins, dystocia may be least if both calves are female

(Sloss and Dufty, 1980). Posterior presentation of the calf may be associated with a higher level of dystocia than anterior presentation (Young, 1968a).

Not all of the losses listed above will occur in every case but the more that do occur, the greater the final loss. An area of loss which cannot be quantified is the distress suffered by owner, stockman and veterinary surgeon when a case of dystocia is not brought to a happy conclusion.

The extent of economic loss suffered by a farmer as a result of dystocia on his farm will depend on the losses sustained at each case of dystocia and also on the incidence of dystocia in his herd. It is possible to attempt to quantify the direct economic loss associated with a case of dystocia. In terms of current (1983) prices the figures might be:-

Replacement of Cow	£850 - £1000
Replacement of Calf	£ 90 - £ 140
Veterinary Fees	£ 20 - £ 100

Indirect losses are less easy to quantify. Morbidity of the cow or her surviving calf may vary greatly in severity and hence in the cost of treatment. In some cases such expenses will not be rewarded by subsequent recovery. A year's loss of milk production may represent income of £700 to the farmer. Delay in conception following dystocia beyond 65 days post partum has been estimated by Beynon (1976) to result in increased daily costs of £2.00 per day.

The most important areas of economic loss will be discussed below:-

Loss of the Calf - Stillbirth

It is probably inevitable in all species that a proportion of foetuses will die during birth. Approximately one-third of all neonatal calf losses occur during the birth process (Sloss & Dufty, 1980). Calves which are born dead are designated 'stillborn' and the percentage measure of parturient foetal death is termed 'still birth rate' (S.B.R.). Many authors have published figures of SBR for cattle but not all agree on the definition of stillbirth. Most, including the author of this thesis, use the term to describe foetal death occurring during the birth process. In some works a wider definition is used. Lindhe (1966) for example has defined stillbirth as representing 'calves which die before, during or after birth, but not later than twenty-four hours post partum'.

Kirkbride et al. (1973) warned that the investigation of still-

birth was 'notoriously difficult' and considered that signs of intra-partum death should include the following:-

- a) A history of dystocia
- b) Specific lesions of injury e.g. fracture, oedema or congestion of the head.
- c) Partial expansion or atelectasis of the lungs
- d) Excessive amniotic fluid in trachea and bronchi
- e) Absence of lesions suggesting an infectious cause of death
- f) Failure to demonstrate recognised agents of infectious abortion.

Calf mortality is affected by many factors and Rasbech (1967) in a review of the literature considered that whilst some were well understood, others might require further clarification.

Anderson and Bellows (1967) in their study of 124 stillborn calves considered that in most cases death was due to injury following difficult or delayed birth. Noting with other authors that anoxia played an important role in the aetiology of foetal death, Greene (1978) found that stillbirth was more common among cattle that calved unattended out of normal working hours. Similarly, Dufty (1981) observed that cattle which were closely confined and supervised at parturition suffered a lower SBR than those which were not.

The SBR of cattle within a herd may vary considerably from year to year and in certain areas may be associated with deficiency conditions. Iodine deficiency and resultant hypo-thyroidism has been diagnosed in some areas where a higher than normal SBR was observed (Mills, 1935a, 1935b; Allcroft et al., 1954; Dawson, 1958; Wilson, 1975).

Normal Stillbirth Rate in Cattle

Surveys have suggested that the overall stillbirth rate in cattle is within the range 2.5-7.0 per cent (Lovell & Bradford-Hill, 1940; Withers, 1955; Wright, 1958; Woodward, 1959; Hansen, 1966; Anderson & Bellows, 1967; Rasbech, 1967; McClure & Dowell, 1968; Wijeratne & Stewart, 1970; Speicher & Hepp, 1973; Kay, 1978; Sloss & Dufty, 1980). In their survey, Hartman et al. (1974) recorded an average SBR of 8.2 per cent which was based on farmers' records rather than on a clinical study which might account for a higher figure than that noted in the other surveys. These generalised

overall figures can be quite misleading and can cover up heavier losses than might be suggested. On a well managed dairy farm near Edinburgh for the year 1978-79 Plews (personal communication) reported an overall stillbirth rate of 9.3 per cent. Among cows SBR was 5.2 per cent but amongst heifers calving the SBR was 18.6 per cent - that is almost one calf in five delivered by primiparous heifers was born dead.

No evidence of seasonal variation in SBR was observed by Lovell and Bradford-Hill (1940) or Hartman et al. (1974). Although Stansfield (1969) warned of the difficulties of attaining good stockmanship in large herds, Hartman et al. (1974) found no evidence that SBR was higher in large herds than it was in small herds.

Factors Affecting Stillbirth Rate in Cattle

SBR may be influenced by many factors and as in the case of the incidence of dystocia it may be unwise to attach too much significance to each.

Breed may exert an influence upon SBR. Lindhé (1966), Wijeratne and Stewart (1970) and Allen (1976) all found that the mean level of stillbirth among Aberdeen Angus Cattle (2.6 per cent) was considerably lower than that seen in Charolais (5.1 per cent). It is interesting to note that SBR in these breeds is paralleled by the incidence of dystocia found in the breeds. Although Laster and Gregory (1973) considered pure bred cattle were likely to suffer a higher SBR than crossbred animals this was not always seen in the results of their survey. Aberdeen Angus heifers mated by Jersey or Charolais bulls were found to have a SBR of 5.5 per cent and 14.5 per cent respectively. Rasbech (1967) warned that there might be a 'sire effect' influencing SBR as was also seen influencing the incidence of dystocia. This 'sire effect' was in Rasbech's view particularly likely to be seen in the progeny of primiparous heifers and he suggested that 500 calvings should be monitored for SBR for each A.I. bull.

Heifers are more likely to produce stillborn calves than are older cows (Rasbech, 1967; Greene, 1978) and Woodward and Clark (1959) working with range cattle found a SBR of 6.7 per cent in heifers compared with 2.4 per cent in cows. In Britain, Plews (personal communication) and Edwards (personal communication)

recorded up to 19 per cent SBR among their heifers but only 5.2-7.4 per cent among their cows.

Both sex of the calf and its presentation may influence SBR. Anderson and Bellows (1967), Rasbech (1967) and Wijeratne and Stewart (1970) were among authors who observed a higher SBR among male than female calves. Woodward and Clark (1959) considered foetal death more likely to occur in calves born in posterior presentation than in those born in anterior presentation.

At one time it was considered that twinning in cattle should be encouraged in an attempt to improve beef production (Hammond, 1959) but many veterinary surgeons were concerned about this proposal and Grant (1959) proposed that clinicians should report any difficulties encountered following induced twinning. Crew (1960) reported his experiences with human twins and warned of the dangers of encountering a high level of stillbirth should an attempt be made to make an essentially monotocus animal into a polytocus one. Herschler et al. (1962) suspected an association between twinning and SBR and this was quantified in other reports. Daerr and Grünert (1970) considered that foetal death was three times more likely to occur in twin births than in the births of singletons. Surveys by Rasbech (1967) and Kay (1978) recorded stillbirth in approximately twenty per cent of twin births compared with five per cent of singleton births.

Induction of birth may be associated with an increase in SBR and O'Farrell and Crowley (1974) in a study involving 35 cows found that SBR was particularly high in cows induced prior to day 260 of gestation.

The Incidence of Stillbirth in Cases of Bovine Dystocia

The occurrence of dystocia and any delay in its correction will inevitably increase the risk of stillbirth. Some of the physiological changes which take place during parturition, such as placental separation, may proceed whether or not there is any delay in the passage of the foetus. A number of authors have quantified the increase in SBR which is evident when calf survival in dystocia and normal birth are compared. Wright (1958) recording his experiences in five herds attended by the Liverpool Veterinary School found SBR levels of five per cent and twenty per cent in normal and difficult

calvings respectively. Similar figures were reported by Laster and Gregory (1973) and by Smith et al. (1976). Hansen (1966) considered that SBR might be ten times higher at 35 per cent in dystocia cases than it was in normal birth. Sellers et al. (1968) in a survey of 710 calf deaths found the highest SBR in heifers calving for the first time and suffering dystocia. The overall level of stillbirth fell for the second and third parities but rose again for the fourth parity. In his study of 200 heifer dystocia cases Williams (1967, 1968) reported that 40 per cent of calves were stillborn.

Cow Wastage and other losses in Bovine Dystocia

A number of surveys into maternal loss of life or production following dystocia have been reported in the literature. In a series of 95 assisted calvings, Wright (1958) recorded a maternal death rate of three per cent. Sloss (1974b) found a death rate of six per cent among heifers which suffered dystocia but noted a breed difference in maternal loss. Jersey heifers suffered 4.8 per cent mortality rate whilst in Hereford heifers the figure was much higher at 28.4 per cent. In his series of 200 heifer dystocia cases Williams (1967, 1968) considered his maternal death rate of 7.8 per cent as being 'too high'. Earlier studies by Armstrong (1927) and by Tutt (1944) reported maternal death rates of 2.7 per cent among 1408 cases and sixteen per cent among 97 cases respectively. Tutt's figures were somewhat inflated by the fact that he included emergency slaughter with deaths following attempted treatment of dystocia. In both surveys high mortality rates were associated with rupture of the uterus and overwhelming post-parturient infection. It is possible that some of these cases might have been saved by the use of antibiotics but in the author's experience even these modern aids to therapy will not save all cases.

Withers (1955) in surveys of 120 and 160 herds found that 5.6 per cent of cows in the national herd were culled annually and that one-third of these cases were culled following calving difficulty. More recently Beynon (1976) in a survey of 25,000 cows in 1972 found that 2.3 per cent were culled following calving injury although not all were a total loss to the farmer. In a survey of 180 Friesian herds in East Anglia, Young et al. (1983) found that 3.4 per cent of breeding animals aged one to three years were culled for calving

problems. A remarkable 31 per cent of this age group were culled for breeding problems. Rather surprisingly McClure and Dowell (1968) in a survey of 55 Australian herds over the years 1963-5 found that culling through calving injury only accounted for 0.1 per cent of culling losses. Special problems may be associated with extra high levels of loss and Donald et al. (1952) who reported on a problem of dropsical calves in 66 herds of Ayrshire cattle noted that 20-30 per cent of cows producing such calves either died or underwent embryotomy.

The duration of calving was believed to be a major factor in cow and calf survival by Christiansen (1967) but Straiton (1960) who advocated a policy of non-interference in dystocia cases considered that such a policy would lower the maternal death rate albeit at the expense of an elevated foetal SBR.

Both Hansen (1966) and Sloss (1974b) considered that at least 20 per cent of all animals suffering dystocia might be expected to sustain some damage even though this might not be of a serious nature. Sloss (1974b) noted 'the importance of minimising trauma to the birth canal and of early veterinary attention is emphasised. Maternal death may result from a combination of unfavourable clinical conditions at the time of parturition'. Many years earlier Samson (1865) observed that 'after treatment of dystocia many animals die with symptoms of severe inflammation' and he considered that this was probably associated with the presence of 'large clots of extravasated blood in the areolar tissue around the vagina'.

Recent work has thrown more light upon the problem of post-partum infection. In a study of 1330 cows which had suffered dystocia Baier et al. (1973) found that despite prophylactic antibiotic therapy over 95 per cent of the animals had abnormal bacterial populations within their genital tracts. Later work by Bostedt et al. (1979) found that cows which had suffered dystocia were twice as likely to be harbouring pathogenic *E. coli*, *Proteus vulgaris* and *Staphylococcus aureus* in their genital tracts than cows which had calved unaided.

One particularly unpleasant consequence of dystocia (often complicated by hypo-calcaemia) is the 'downer cow' which is recumbent after calving. This condition has been reviewed by Fenwick (1972) and Cox et al. (1982) and is often accompanied by a poor prognosis. Severe economic loss may occur in such cases since after a long period

of costly treatment the animal may still be unable to resume her place in the herd. The clinical aspects of both post parturient infection and recumbency will be discussed later in this thesis.

The longer-term effects of dystocia and its treatment are also of great importance. Christiansen (1967) in a study of 308 caesarean sections found that only 25 per cent of his cases bred again whilst both Williams (1931) and Cooper (personal communication) questioned the value of caesarean section when compared with emergency slaughter. The problem of the dead and emphysematous foetus is a serious one for the veterinary obstetrician and in a series of 126 cases Frerking et al. (1972) found that only 32.5 per cent of cattle bred again following the delivery of such a calf. Kay (1978) in his investigation of the consequences of twin calving not only noted a high level of dystocia, but also observed that some 20 per cent of animals which carried twins were unlikely to breed again.

Overall conception rate following dystocia was found to be 15.6 per cent lower than after normal calving (Laster et al., 1973). Brinks et al. (1973) studied the longer-term effects of an earlier dystocia in breeding cattle. They found that a group of heifers which had suffered dystocia reared eleven per cent fewer calves one year after their dystocia and fourteen per cent fewer calves two years after their dystocia than animals which had not experienced dystocia.

Subsequent calves were also believed to be affected by the previous dystocia. Calves from three-year-old animals, which had suffered dystocia as two-year-olds, were born on average thirteen days later and were 21 Kg lighter at weaning than calves produced by animals with no history of dystocia.

CHAPTER SIX

CAUSES OF BOVINE DYSTOCIA

As Schuijt and Ball (1980) pointed out, dystocia may be said to occur when any stage of physiological birth is either 'slow to develop or fails to progress normally'. Foetal expulsion from the uterus is achieved by involuntary uterine contraction reinforced by voluntary contraction of the abdominal muscles. Failure of either of these expulsive forces may result in dystocia. During birth the foetus passes through the birth canal which is, for some of its length, encircled by the bony pelvis. To allow passage of the foetus the birth canal must relax and dilate sufficiently to allow the correctly orientated foetus to pass through. Failure of the birth canal to dilate, any disparity between the size of the foetus and the bony pelvis or any faulty foetal disposition may result in dystocia. (The term 'faulty foetal disposition' (Arthur, 1975) has been used in this thesis to describe defects of presentation, position and posture in the foetus which have resulted in dystocia. The more traditional term 'foetal malpresentation' has been reserved for abnormalities of presentation only.)

Since normal birth has both maternal and foetal components, many authors have attempted to classify the causes of dystocia into maternal and foetal groups. In maternal dystocia the fault or abnormality can be assigned to the mother whilst foetal abnormalities resulting in dystocia are termed foetal dystocia. Realising that few cases of dystocia are caused by one single factor, other authors have suggested that the causes of dystocia might be more satisfactorily divided into basic and immediate groups. The basic causes of dystocia exist before the birth process begins whilst the immediate causes arise during the birth process.

In some cases encountered in practice the cause of dystocia may be readily identified and assigned to one of the categories of dystocia mentioned above. The author can however recall many cases in which, on reflection, he was unable to classify satisfactorily under one particular category.

Accounts of the causes of bovine dystocia are frequently met with in the 19th Century literature but few go further than listing some of the causes of dystocia the authors have encountered in their own practices. It was not until the present century that more comparative studies were undertaken and attempts made to demonstrate numerical differences in the incidence of the various causes of dystocia.

In his 'Instructions for the Extraction of Calves' Downing (1797) described a number of examples of faulty foetal disposition. No other form of dystocia was described and it may be assumed that foetal mal-disposition was the most important cause of dystocia seen at that time. The beautiful illustrations of faulty foetal disposition by Skellett (1807), later copied by Simonds (1849) depict dystocia caused by bilateral shoulder flexion, lateral and ventral deviation of the head, ventral position and breech presentation. Dystocias caused by foetal hydrocephalus and by foetal ascites were also illustrated.

Faulty foetal disposition was also described by Crundall (1848) as a cause of bovine dystocia and this author had encountered other cases caused by foetal monsters and by obstruction of the cervix - 'scirrhus os'. This latter condition he considered rare and on some occasions it was associated with excessively early intervention in normal calving cases.

Simonds (1849) suggested that causes of dystocia might be classified according to the nature of the animal's labours. His classification of parturition included the categories 'Natural, Preternatural, Premature, Protracted, Impractical, Instrumental and Complicated'. His divisions seem rather arbitrary. 'Natural labour' might be 'quick, lingering or twin' whilst both 'Preternatural' and 'Premature' labour included 'every kind of malpresentation'. Mechanical impediments and 'imperfect throes' might contribute to 'Protracted labour' whilst 'Complicated labour' was associated with such disasters as uterine rupture and haemorrhage.

Armatage (1860) was one of many authors who found lay interference to be an extra complication of dystocia. He found the main causes of dystocia in his practice to be malposture of the head or forelegs and premature labour. Cartwright (1865b) who had consider-

able obstetrical experience also considered foetal mal-disposition an important cause of dystocia as was obstruction of the birth canal. One particular cause of the latter problem was the presence of a ligamentous band stretching across the vagina in the cervical region. In an earlier paper Cartwright (1845b) had noted that he occasionally saw cases of dystocia caused by foetal oversize and that certain bulls might sire calves with abnormally large heads and hips.

In an extremely comprehensive paper, Farrow (1865) gave a concise account of his view of the causes of bovine dystocia. Writing some years before the publication of the first British textbook of veterinary obstetrics, Farrow considered the causes of dystocia were:-

- 'a) For want of that natural preparation of the part through which a foetus must pass,
- b) For want of muscular power in the uterus to press forward its content arising in consequence of over-distension with unnatural fluid in the uterus,
- c) Morbid enlargement of the foetus - dropsy and decomposition.
- d) Unnatural presentation of parts whereby the foetus cannot pass the pelvis and external parts'.

Maternal and foetal categories of dystocia were proposed by Fleming (1877). Maternal causes included:-

- a) Pelvic constriction,
- b) Displacement or altered relations of the uterus,
- c) Morbid alterations of the maternal organs,
- d) Shortening and other abnormalities of the umbilical cord.

Fleming's reference to problems concerning the umbilical cord is most interesting since, although they are not infrequently seen in human obstetrics, they are seldom reported to occur in cattle. Michelat (1966) did however describe three ways in which the cord may become entangled with the extremities of the foetus producing dystocia.

Foetal causes were just two in number:-

- a) those independent of foetal disposition,
- b) those dependent on foetal disposition.

The first category included abnormalities such as foetal oversize, excessive hair growth, monstrosities and multiple birth. The second

category consisted of the various malpresentations, malpositions and malpostures.

Gibbings (1896), Dalrymple (1898) and Crichton (1902) all noted the occurrence of foetal mal-disposition and obstruction of the birth canal as causes of dystocia. Edwards (1902), who like Cartwright, had a particular interest in obstetrics made a plea for more information on the relative incidence of the various causes of dystocia. 'It would be interesting' he said 'if statistics could be collected from various districts giving numbers of cases, presentations and other particulars for comparison'. It was unfortunately to be over 40 years before this request was to be fulfilled. Amongst other specific problems mentioned by Edwards was the occurrence of foetal oversize which he considered might follow the use of a large bull on a small cow.

Faulty foetal disposition and obstruction of the birth canal were also mentioned by Taylor (1903) who subdivided problems related to the maternal cervix. The impassable cervix might be either rigid - possibly a sign of premature interference which might resolve with time or, more seriously, indurated with fibrous tissue. In these latter cases Taylor warned that caesarean section might have to be considered. Uterine rupture compounded by passage of the foetus into the abdomen was noted as a cause of dystocia by Grimal (1903). Describing his experiences in a Devon practice Penhale (1906) agreed with Fleming (1877) that causes of dystocia might be classified under maternal and foetal headings. In Penhale's experience pelvic deformity or damage, torsion of the uterus and spasm of the cervix were important maternal causes. Insufficient or excessive labour pains could also be a problem. Foetal oversize, possibly complicated by deformity or emphysema, malpresentation and multiple birth were important foetal causes of dystocia.

No mention of foetal oversize was made by Anderson (1926) but among cases of faulty foetal disposition encountered in his practice, lateral deviation of the calf's head and the breech presentation were the most common. Obstruction of the birth canal by either rigidity of the cervix or torsion of the uterus was also discussed.

In 1931 W.L. Williams expressed disquiet at the paucity of knowledge concerning the basic causes of dystocia. Prevention of

disease, including dystocia, could only be achieved if the cause was known and could be avoided. He further expanded these considerations in the next edition of his book (Williams, 1943). In Williams' view the causes of dystocia could be divided into two groups:- a) basic or fundamental b) exciting or immediate. He considered that many of the basic causes had their origin at the time of conception and might be avoided by responsible breeding policy. Williams listed some eighteen possible basic causes which included such hereditary abnormalities as genital hypoplasia, bulldog calves and hydrocephalus. He considered twin ovulation to be 'pathological' in view of the high incidence of dystocia in twin birth. Torsion of the uterus, which he considered to be the result of bad management was classified as a basic cause of dystocia. The exciting causes of dystocia were only two in number - maldisposition or excessive volume of the foetus.

Benesch (1938) gave relatively little consideration to the causes of dystocia in his book, being far more concerned with actual delivery of dystocia cases. Foeto-pelvic disproportion was considered an important cause of bovine dystocia. For other causes of dystocia Benesch proposed another classification and he divided them into internal and external causes. His internal causes included torsion of the uterus, foetal death and premature rupture of the foetal membranes. He noted that premature membrane rupture might be caused by abnormally thin membranes or by excessive uterine contraction. Hereditary abnormalities, including foetal monsters were also described as being internal causes. Benesch described external causes as being 'insufficient dilation of the soft parts of the genital passage which results in faulty presentation, position or posture of the foetus'. Such external causes were often complicated by lay interference with premature rupture of the foetal membranes and crude attempts at reposition.

In general Williams' (1931a) basic and exciting causes could be equated with Benesch's (1938) internal and external causes. It would appear from the translation of his book, that Benesch considered all cases of faulty foetal disposition to be associated with failure of the soft tissues of the birth canal to dilate fully.

Despite Edwards' (1902) plea for a comparative survey of the causes of dystocia, such surveys of dystocia as continued to appear

gave no numerical comparisons. In a somewhat superficial account, McCorry (1932), reporting on his experiences in the Irish Republic, considered the causes of dystocia under maternal and foetal headings. Maternal dystocia might be either a) premature labour or b) scirrhus os about which McCorry confessed he knew 'nothing'. His foetal causes included foetal mal-disposition and disease of the foetus. He noted that foetal malpostures involving the head and limbs were 'more frequent and less troublesome' in the cow than in the mare.

A report by Wright (1939) on his clinical experiences also considered dystocia under maternal and foetal headings. His practice was in Cheshire and it is interesting to note that foetal oversize as a cause of dystocia is not mentioned. A survey in the same geographical area nearly 30 years later (Morten and Cox, 1968) demonstrated the increasing importance of this type of dystocia.

In 1944 Tutt reported on 97 cases of dystocia encountered in his practice and provided the first true comparative study of the various causes of dystocia. The results of Tutt's survey are tabulated and discussed below along with five other 'numerical' studies (Wright, 1958; Friedli, 1965; Sloss and Johnston, 1967; Morten and Cox, 1968; Mutiga et al., 1981) (Tables 6 and 7).

Anderson (1958) did not consider the traditional headings of maternal and foetal causes of dystocia to be satisfactory and noted that many cases were a combination of both and that other 'extraneous' causes might also be involved. He listed six groups of causes, which despite his earlier protestations, included the terms 'maternal' and 'foetal'. His six groups were as follows:-

- a) Time factors - disease or injury leading to premature expulsion of the foetus through an illprepared birth canal.
- b) Mechanical factors - including torsion of the uterus and developmental remnants obstructing the birth canal. Also included, rather surprisingly in this group, was uterine inertia.
- c) Concurrent disease - hypocalcaemia.
- d) Maternal dystocia - here Anderson refers rather loosely to 'conditions mentioned above' together with atresia of the cervix, pelvic abnormality and hydrops.
- e) Foetal dystocia - malpresentation, position and posture.

- f) Combined dystocia - for example a dead or decomposed foetus complicated by loss of fluids, contraction of the uterus tumefaction of the birth canal and by relative foetal oversize.

It is difficult to see much advantage in Anderson's terminology over the traditional terminology which he objected to. His list of causes is loosely worded and contradictory. He considered uterine inertia might be included under mechanical factors - possibly here he was considering secondary uterine inertia - and then listed hypocalcaemia, an important cause of primary uterine inertia, under concurrent disease. It is also surprising that pelvic abnormality appears under 'maternal factors' rather than under 'mechanical factors'.

Another classification of causes of dystocia suggested by Roberts (1971) bore some resemblance to that of Williams (1931a). Roberts divided the causes into a) basic and b) immediate groups. Basic causes included hereditary, nutritional and managerial, infectious, traumatic and miscellaneous or combined problems. He considered that many cases might have two or more basic causes and that most basic causes were avoidable. Under 'miscellaneous' problems he included 'minor malpresentations' which might result from 'accidental catching of the nose or foot on the pelvic brim'. Faulty foetal disposition was further considered under Roberts' 'immediate' category. Here he referred to maternal and foetal causes. The maternal group included obstruction of the birth canal with possible secondary uterine inertia whilst the foetal group, which Roberts considered the more common, comprised foetal oversize and foetal mal-disposition. Commenting on the relative incidence of the various categories of bovine dystocia Roberts noted that disproportion between foetal and pelvic size was 'common' as was dystocia caused by twin pregnancy and uterine torsion. Uterine inertia and failure of the cervix to dilate were 'occasionally seen'. Foetal giantism, hydrops and emphysema were 'not uncommon' whilst foetal monsters had a higher incidence in cattle than in other species.

Roberts' classification and those which have preceded it emphasise the difficulty in devising an entirely satisfactory scheme. Sloss and Dufty (1980) attempted to deal with the problem in another

way. Having reviewed earlier unsatisfactory attempts at classification they used a scheme based upon 'the main clinical manifestations observed at the time of parturition'. Each of the problems listed was however further discussed under basic and immediate causes. Sloss and Dufty's (1980) list of causes was as follows:-

- a) Foeto-pelvic disproportion
- b) Ineffective labour - including uterine inertia and failure of cervical dilation,
- c) Constriction of vulva, vestibule or vagina,
- d) Displacement of the gravid uterus,
- e) Deformities of the birth canal - including pelvic deformity; neoplasia and congenital soft tissue defects,
- f) Death or decomposition of the foetus during parturition,
- g) Incorrect alignment of the foetus,
- h) Multiple pregnancy,
- i) Foetal malformation,
- j) Uterine rupture and extra-uterine foetus.

Although it is possible to criticise Sloss and Dufty's classification it is nonetheless well thought out and effective. It might be thought that bony deformity of the birth canal should be included under the heading of foeto-pelvic disproportion. Pelvic size was indeed discussed under the latter heading but pelvic deformity causing dystocia was grouped with neoplasia and congenital deformities such as double cervix. Incomplete dilation of the cervix was considered under the heading of ineffective labour, the authors considering the neuromuscular changes involved to be part of the whole process of labour.

One of the most comprehensive attempts to classify the causes of dystocia was that of Arthur et al. (1982). Based on earlier work by the senior author the causes of dystocia were displayed in diagrammatic form. Maternal dystocia was attributed to either defective expulsive forces or to abnormalities of the birth canal. The expulsive forces were considered under uterine and abdominal headings whilst the problems of the birth canal were divided into pelvic inadequacies and insufficient dilation of the soft tissues. Foetal dystocia was considered under three headings - foetal over-size, foetal maldisposition and foetal death.

Comparative Surveys of Causes of Dystocia

The six surveys mentioned above in which numerical comparison was made of the various causes are set out in summarised tabular form below (Tables 6 and 7).

Table 6 Surveys of the incidence of bovine dystocia

Survey	Year	Country	Type of Cattle	N ^o of Cases	% Maternal Cases	% Foetal Cases
Tutt	1944	U.K.	Dairy	97	14*	76*
Wright	1958	U.K.	Dairy	95	24	76
Friedli	1965	Switzerland	Mixed	894	23	77
Sloss & Johnston	1967	Australia	Beef	635	24	76
Morten & Cox	1968	U.K.	Dairy	200	28	72
Mutiga et al.	1981	Kenya	Dairy	83	36	64

* In Tutt's survey seven cases were equally attributable to maternal and foetal causes.

Table 7 Surveys of the causes of bovine dystocia

Survey	<u>Maternal Causes</u>			<u>Foetal Causes</u>			
	Uterine Inertia	Obstruction of birth canal	Other*	Foetal Oversize	Faulty Foetal Disposition	Foetal Monsters	Other**
	%	%	%	%	%	%	%
Tutt (1944)	-	14.5	-	4	70	1	10.5
Wright (1958)	18	6	-	56	16	1	3
Friedli (1965)	10	12	-	37	40	1	-
Sloss & Johnston (1967)	5	17	1.5	46	26	4.5	-
Morten & Cox (1968)	14	14	7	17	34	4	10
Mutiga et al. (1981)	12	24	-	11	47	2.5	3.5

* e.g. uterine rupture. ** chiefly dystocia associated with multiple birth.

Some difficulty was experienced in attempting to analyse and compare the surveys which are tabulated above. Tutt (1944) did not himself attempt to tabulate or compare the relative incidence of the different causes of dystocia in his 97 cases. Morten and Cox (1968) discussed factors associated with cause rather than cause alone and in addition apparent arithmetical errors are to be found in the column additions of their original paper. It may also be somewhat invalid to compare European surveys with those from Australia and Africa. Nonetheless a number of interesting facts emerge.

It is interesting to note that Tutt (1944) did not recognise uterine inertia in his survey and that the incidence of foetal oversize was so much lower than that encountered by Wright (1958) just over ten years later. Tutt's cattle were almost all Shorthorn and Guernsey animals and the emergence of the Friesian as the most popular dairy animal was in Wright's view the reason for the high incidence of foetal oversize in his survey. The later survey of Morten and Cox (1968) again revealed a lower level of foetal oversize and this may be attributed to a more cautious breeding policy particularly of Friesian heifers. In their Kenyan study Mutiga et al. (1981) also encountered less foetal oversize than foetal malpresentation and although Friesian cattle accounted for some 25 per cent of their cases, the other breeds were Guernsey, Jersey, Ayrshire and Zebu. Sloss and Johnston's (1967) survey of beef cattle found foetal oversize to be the most important cause of dystocia.

Despite the diversity of the above surveys and the difficulties of interpretation in some cases, it is clear that dystocia associated with foetal causes occurs more frequently than dystocia due to maternal cause. The overall incidence of causes of dystocia may be ranked as follows:-

- a) foetal mal-disposition,
- b) foetal oversize,
- c) obstruction of the birth canal,
- d) uterine inertia,
- e) foetal monstrosities,
- f) other causes.

Both Dufty (1972, 1973) and Rice and Wiltbank (1972) published accounts of the incidence of the various types of dystocia in heifers

only. Dufty noted that vulval constriction was the most important cause of dystocia among 104 Hereford heifers. In their study Rice and Wiltbank found that in one group of 93 Aberdeen Angus heifers vulval stenosis accounted for 54.6 per cent of dystocia cases, other causes being foetal oversize (28.6 per cent), uterine inertia (11.4 per cent) and foetal malpresentation (5.2 per cent). In another group of 90 Hereford heifers Rice and Wiltbank (1972) found that foetal oversize and foetal malpresentation each accounted for approximately 50 per cent of dystocia cases.

It is possible that as knowledge of the physiology of normal birth increases so may our knowledge of the causes of foetal mal-disposition. Already there is evidence that the balance or imbalance of foetal and maternal hormones may influence the disposition of the foetus at the time of birth (O'Brien and Stott, 1975; Silva, 1979; Takeishi, 1980). Much information is already available concerning the factors which influence the problem of foetal oversize but the incidence of this form of dystocia in British herds suggests that much more must be done in the future to take preventive action.

These and the other individual causes of bovine dystocia will be considered in greater detail in subsequent chapters.

CHAPTER SEVEN

DYSTOCIA CAUSED BY EXPULSIVE DEFICIENCY

Arthur and others (1982) provided a detailed and comprehensive analysis of the way in which maternal dystocia caused by expulsive defects might occur. The expulsive components of normal birth, uterine and abdominal contraction, might become deficient either individually or together. Deficiency of uterine contraction, uterine inertia, might be either primary or might follow other forms of dystocia in which case it was termed secondary inertia.

Primary uterine inertia might be caused by i) intrinsic weakness of the uterine musculature, ii) overstretching by multiple pregnancy or excessive uterine fluids, iii) toxic degeneration, iv) fatty infiltration, v) senility, vi) dietary deficiency, vii) systemic illness, viii) deficiency of inorganic ions such as calcium and magnesium, ix) hormone deficiency - lack of oxytocin, oestrogen or progesterone imbalance, x) premature birth and xi) environmental disturbance.

Secondary uterine inertia might be the result of other forms of dystocia such as obstruction of the birth canal or foetal malpresentation. Rupture of the uterus and torsion of the uterus might also cause failure of uterine contraction. In this thesis, whilst it is recognised that torsion of the uterus in some cases may result in failure of uterine contraction, this problem will be considered separately in the section dealing with obstruction of the birth canal (Chapter Eight).

Deficiency of abdominal contraction according to Arthur and others (1982) might be caused by i) age, ii) debility, iii) pain, e.g. traumatic reticulitis, iv) factors preventing efficient straining e.g. ruptured diaphragm, herniation of the abdominal wall or perforation of the trachea. There are, however, few specific references to dystocia from this cause in the literature. Paton (1902) reported a case of dystocia in a Jersey heifer which had suffered ventral hernia of the abdominal wall and in which the further complication of lateral deviation of the foetal head was

present. The foetus, which was almost beyond reach in the displaced uterus was withdrawn with the aid of an obstetrical hook. The heifer was fitted with a truss to support the hernia after foetal delivery but one week later was reported to be 'not at all hearty'. Sloss and Dufty (1980) advised that any lost uterine fluid should be replaced in such cases and the cow placed in sternal recumbency. The upward pressure exerted upon the gravid uterus might make the calf more accessible to the obstetrician. Dystocia does not always accompany ventral hernia and Arthur et al. (1982) recalled cases in which cows suffering the condition had calved unaided. Uterine inertia is of course only one contributory factor in dystocia associated with ventral hernia. Obstruction of the cervical region of the uterus may occur if the uterus is displaced deeply into the hernia. Bedel (1906) believed that retroflexion of the uterus might occur in cases of ventral hernia but gave no specific examples.

Uterine inertia, overdistension of the uterus and spontaneous rupture of the uterus will be considered in this chapter. Multiple birth, in which case dystocia may occur as a result of overdistension of the uterus or simultaneous foetal presentation, will be dealt with in a separate chapter (Chapter Nine).

Uterine Inertia

Lack of uterine contraction as a cause of dystocia has long been recognised (Allinson, 1834; Farrow, 1865; Fleming, 1877). The term uterine inertia was apparently not used in veterinary obstetrics until some years later (Clark, 1894; Marston, 1897). Clark considered that uterine inertia was one of the worst problems that the veterinary obstetrician had to deal with in cattle. He considered the condition to be more common in the cow than in the mare and suggested that the reasons for this might be the fact that the cow was bred every year, was poorly cared for and was more liable to tuberculosis of the uterus. Great variation in signs might be seen. Calving approached normally and then uneasy paddling movements might be seen. The vulva and vagina were often abnormally dry. Labour pains were feeble and the liquor amnion and the foetus both showed a tendency to rapid putrefaction.

Williams (1943) gave a detailed description of the findings in

bovine primary uterine inertia. The genital organs of the patient were apparently normal anatomically and the cervix was dilated or dilatable. The foetus was at or near term, alive or only recently dead and had undergone no important post mortem changes. Birth was not obstructed by any abnormal presentation, position or posture. One or both membranes might have ruptured. No material progress was made and the only recognisable explanation of abnormality was an absence of vigorous expulsive efforts. The uterus had evidently contracted somewhat and had dilated the cervix but not sufficiently to engage the foetus in the birth canal. Sloss and Dufty (1980) warned of the dangers of confusing uterine inertia with the early signs of normal birth. Primary uterine inertia is seen chiefly in the older dairy cow (Williams, 1943; Roberts, 1971). The association between hypocalcaemia and uterine inertia is now well known but before milk fever was known to be caused by calcium deficiency, the association between it and uterine inertia was none the less recognised (Taylor, 1920; Bray, 1921; Gregory, 1923; New, 1926b; Wilson, 1926). Bray (1921) described what he termed 'parturient apoplexy' prior to delivery. He was called to a crossbred cow ready to calve but making no progress. He delivered the calf manually by which time the cow was in a semi-comatose state. Udder inflation produced recovery in six hours. Bray observed 'trying to calve and having milk fever at the same time seemed somewhat unusual'.

Lagneau (1964) warned that hypocalcaemic uterine inertia might occur as a herd problem. He described a case in which all multiparous cows in a herd suffered uterine inertia in two successive years. All cases responded to calcium therapy but apparently no calcium assays of the blood were made. Mayer et al. (1966) noted that clinical signs were not necessarily good indications of calcium status. They suggested that calcium deficiency could exist without external signs and could cause complications at parturition especially in cows which had not been eating too well. Cows suffering from uterine inertia and other forms of dystocia often had lower calcium levels than normal parturient cows according to Bostedt (1974) and these depressed calcium levels often persisted longer than in normal parturient cattle. Sloss and Dufty (1980) warned that milk fever was likely to recur at subsequent parturitions unlike other forms of uterine inertia.

Heifers bred at an early age might be particularly susceptible to uterine inertia according to Jackson (1963). Uterine inertia may also be caused by stress. Young and Blair (1974) suggested that uterine inertia might 'be the result of stress resulting from overcrowding and a high frequency of human contact', a point also made by Dufty (1981). The 'fat cow syndrome' (Morrow et al., 1979) caused by excessive grain consumption may lead to problems of uterine inertia at parturition. Exercise during pregnancy has been recommended as a preventive measure.

The treatment of uterine inertia in cattle must depend upon the cause. Most authors agree that where hypocalcaemia exists it should be treated specifically after which normal uterine contraction may resume. Should any delay occur, manual delivery by traction following rupture of the foetal membranes should be carried out. Williams (1943) considered that in most cases of uterine inertia, other than those caused by milk fever, uterine activity would resume after a period of time. Such resumption of myometrial activity should not, in the view of the author of this thesis, be relied upon and manual delivery should be adopted in every case. Allinson (1834) advised the use of Ergot of Rye to stimulate uterine contraction whilst the use of pituitary extract was recommended by Anon. (1913a). The effective action of oxytocin on the bovine uterus was described by Fitzpatrick (1954). The use of ecbolics in cases of bovine uterine inertia is not normally considered until after the delivery of the foetus at which time these drugs may encourage uterine contraction together with placental expulsion. When called to such cases the obstetrician is normally able to deliver the foetus with comparative ease and finds little advantage in awaiting the response to ecbolic therapy.

Sloss and Dufty (1980) have suggested that in contrast to uterine inertia dystocia might also arise where excessive myometrial contractions occurred. These authors considered that such activity might result from increased oxytocin release affecting the oestrogen sensitised myometrium. Increased uterine tone resulted and uterine contractions of high frequency and low amplitude occurred in place of the normal peristaltic movements. Cuff-like bands of myometrium clamped down tightly upon the foetus, expelling fluids and preventing delivery. It was suggested that treatment should consist of

myometrial sedation using spasmolytic drugs and that foetal delivery might follow the replacement of lost uterine fluids.

Distension of the uterus with abnormal quantities of fluid

Gross distension of the bovine uterus with fluid and resultant myometrial stretching may lead to the inability of the uterus to contract effectively in the first and second stages of labour. Cartwright (1847a) described the condition as 'hydrops uteri' and in a later graphic account (Cartwright, 1873) he described the changes seen in an affected cow. She was 'so much altered in shape that many travelled miles to see her. She had no appearance of a cow save the head and the tail, and her belly was but three inches from the ground'. Fleming (1877) also noted the severe consequences of the condition which he preferred to call 'dropsy of the foetal envelopes'. After an insidious start abdominal enlargement was noted and colic, tympany and general debility might follow. Rumination was suspended, defaecation and micturition became irregular and in advanced cases dyspnoea might follow as a result of thoracic compression. Further complications including 'rupture of the muscular parities of the abdomen' were seen in a few cases. Fleming also observed 'uterine contractions are weak. The pains are feeble, the os does not dilate and the act of parturition is consequently tedious'.

Much confusion existed in the literature concerning the site of the excessive foetal fluids. Early workers referred to the condition as hydrops amnion or hydramnii but work by Neal (1956) and Arthur (1957) revealed that in most cases excessive fluids were in the allantoic sac and hence the condition should be more correctly termed hydrops allantois. Many years previously de Bruin (1901) had reported that hydrops allantois was much more common than hydrops amnion. Studies by Arthur (1959, 1965, and 1966) established the normal quantities of amniotic and allantoic fluids in cattle at the various stages of gestation and noted the points in gestation at which abnormal accumulation of fluid might occur. In a characteristically succinct account Sloss and Dufty (1980) reviewed the incidence, aetiology, clinical signs, diagnosis and treatment of both hydrops allantois and hydrops amnion which they collectively described as 'dropsy of the foetal sacs'. Hydrops allantois occurred more

frequently than hydrops amnion and the two conditions constituted 0.3 per cent of all bovine dystocias. Hydrops amnion often developed insidiously and was associated in some cases with foetal abnormalities which interfered with the ability of the foetus to swallow amniotic fluid. The foetal membranes were usually normal and if the excessive amniotic fluid was drained it seldom reformed and birth usually occurred at full term. Illustrated below is an example of severe cleft palate in a calf. This calf was delivered by caesarean section following the diagnosis of hydrops amnion in its mother (Plate 11).

PLATE 11



Cleft palate in a calf delivered by caesarean section from a cow suffering from hydrops amnion.

Hydrops allantois on the other hand was in general a much more dangerous condition. Developing rapidly and generally associated with the small but normal foetus, the condition often ended in abortion and in maternal death. Sloss and Dufty (1980) also noted that in cases of hydrops allantois the placentation was abnormal and in the non pregnant horn of the uterus accessory cotyledons were present. The prognosis of hydrops allantois was particularly grave if the cow was unable to rise and no method of treatment was entirely satisfactory. Simpson (1972) recorded eighteen cases of 'hydrops uteri' over a two-year period in a 100-cow herd of Ayrshire cattle in New Zealand. His description did not make it clear which form of hydrops he was describing but he considered the condition to be possibly of an hereditary nature as it was associated with a particular bull.

Crew (1924) recorded a high incidence of hydrops amnion with bulldog calves and Murray (1951) found the condition associated with ankylosed fetuses. Holt (1960) described a case which he classified as hydrops allantois in a $2\frac{1}{2}$ year old animal which allegedly followed a period of nineteen months pregnancy. The calf was found to have an abnormal head and may well have suffered from a pituitary abnormality plus an inability to swallow and the condition may well in fact have been a case of hydrops amnion.

The clinical signs of hydrops are those of gross abdominal distension caused by uterine enlargement. On rectal examination the uterus may be found to be grossly enlarged and in the case of hydrops allantois small abnormal and numerous accessory cotyledons may be palpable in many areas of the uterus. Arthur et al. (1982) noted that the allantoic sac in cases of hydrops allantois might contain over 250 litres of fluid. Williams (1943) observed that the onset of hydrops might be insidious and the loss in condition suffered by the mother could be obscured by the gross abdominal distension. Differential diagnosis of hydrops in both forms may be difficult and the author has found it to be a particular problem in the recumbent cow where detailed clinical examination may, on occasion, be impossible. Multiple pregnancy, peritonitis, ascites and gastric enlargement should all be considered in the differential diagnosis (Pinsent, 1962; Wilson, 1962; Sloss and Dufty, 1980).

Cases of hydrops may occasionally be complicated by other problems. Beale (1940) recorded a case of hydrops allantois in which uterine tuberculosis was confirmed whilst Jakobsen and Simesen (1959) warned that hydrops allantois could be accompanied by maternal renal disease.

Treatment of hydrops allantois may be difficult and is, in many cases, unsatisfactory. Merrick (1851) and Harrison (1887) both advised that if the case was very close to parturition it should be left and assisted when the cow showed signs of going into labour. Similar advice was given much more recently by Arthur et al. (1982). Harrison (1887) observed that 'some empirics spray a little coloured water over the cervix but it seldom helps'. Campbell (1923) and Cooper (1930) advised that an attempt should be made to drain fluid from the uterus after manually dilating the cervix. Draining fluid either per vaginam, through the linea alba or right flank was advised by Cartwright (1847a) who considered that there was little risk of puncturing the bowel which was pushed well forward by the grossly distended uterus. De Bruin (1903) also recommended tapping the uterus via the flank whilst New (1927), Caldwell (1933d), Conisbee (1933) and Olver (1933) all recorded cases in which this was done. In two cases the cows survived treatment but in the others they did not.

Caesarean section may be the best treatment for hydrops cases although Williams (1943) warned that successful outcome was most unlikely especially in the case of recumbent cows. Although Pearson (1973) considered caesarean section more satisfactory than medical termination of pregnancy in hydrops cases, Parkinson (1974) warned that the operation in such cases was often attended by poor chance of survival. Neal (1956) recommended a two-stage caesarean section to avoid the consequences of sudden loss of uterine fluid. On the first day a drainage tube was inserted to remove most of the excessive uterine fluid and was followed 24 hours later by a normal caesarean section operation. A high success rate was recorded. Pearson (1973) preferred to open the uterus, remove the foetus but leave fluids in situ allowing them to drain later via the cervix. In cases of hydrops allantois difficulty may be experienced in actually locating the foetus within the uterus. Cox (1877 a, b) and Harvey (1924)

described this difficulty during manual delivery whilst the author of this thesis has also experienced the problem during caesarean section.

Another approach to treatment, rupture of the foetal membranes, was proposed by Cox (1877a, b) who noted that this method was used to induce birth in women. Induction of birth by enucleation of the corpus luteum was proposed as the treatment by Williams (1943) but the practicality of the suggestion is open to doubt. Golledge (1942) and Crosfield (1944) both reported the use of stilboestrol to induce birth in hydrops cases. Arthur et al. (1982) suggested that dexamethasone injection should be followed four days later by an oxytocin drip. Sloss and Dufty (1980) noted that prostaglandin could be used to induce birth in cases of hydrops but warned that whatever method of treatment was employed great care should be exercised in the supervision of birth. Many years earlier Fleming (1877) had stressed the importance of post-operative care and Williams (1943) and Ball and Brand (1980) have also pointed out the dangers of retained placenta and of metritis in cases of hydrops. Induction of birth by steroid and prostaglandin therapy unfortunately takes a few days to be effective and in cases of cows which have become recumbent whilst suffering from hydrops allantois this delay may prove fatal. In the opinion of the author of this thesis caesarean section may prove to be the best solution to this problem although the operation, in such difficult circumstances is not without risk. Illustrated below is a case of hydrops allantois in a Friesian cow. This case was in good condition when admitted for hospital treatment at the Royal (Dick) School of Veterinary Studies and a living but small foetus was delivered by right flank caesarean section. (Plate 12 and 13).

PLATE 12

Hydrops Allantois in a Friesian cow - the photograph taken prior to caesarean section shows gross abdominal distension.

PLATE 13

Hydrops Allantois in a Friesian cow - post-operative appearance. The cow made a good recovery.

The problem of post-parturient infection has already been mentioned and illustrated below is the uterus from a cow in a less successful case of hydrops allantois in which parturition was induced by a combination of stilboestrol and dexamethasone therapy (Plate 14).

PLATE 14



Uterus from a cow with hydrops allantois - evidence of severe metritis is present. Large cotyledons covered with caseous debris are to be seen in the pregnant horn (right of picture) whilst in the non-pregnant horn (left of picture) small accessory cotyledons are visible surrounded by inflamed endometrium.

Despite careful prophylactic antibiotic and nursing attention the cow succumbed to a fatal metritis from which *Aspergillus* organisms were isolated. The illustration of the uterus at post mortem not only demonstrates the acute inflammation which was present but also differentiates the normal sized cotyledons in the pregnant horn of the uterus and the small accessory cotyledons in the non-pregnant horn.

Uterine rupture

Dystocia, haemorrhage, peritonitis or prolapse of maternal intestine may occur as a result of uterine rupture. According to Pearson and Denny (1975) who described their findings in 26 cases, uterine rupture was a relatively uncommon complication of late pregnancy. These authors recorded an incidence of three per cent in a total of 1004 referred obstetrical cases. Most of their cases occurred in cattle between the ages of two and four years and there was no obvious difference in incidence between the various breeds. The clinical findings in cases of uterine rupture caused some consternation among early workers. A rural cleric (Berry, 1834) described what he considered to be an 'extra uterine conception in a heifer'. Vaginal examination revealed that there was 'no inmate in the womb'. As no veterinarian was available a local 'sporting celebrity' paid a visit and satisfied himself that there was a calf in the abdomen. It was decided that a caesarean operation should be performed and it was carried out by 'a professional gentleman who attended the family'. The unfortunate heifer did not survive and at post mortem the foetus was found in 'a mass of fungal material' which was probably placenta.

Rupture of the uterus may occur spontaneously or may result from attempts to correct an existing dystocia. In a series of eight cases De Nooij (1981) noted that four cases had occurred spontaneously, two whilst traction was being applied to the foetus, one during embryotomy and one during the manipulation of a malpresentation. Vigorous movement of the foetal limbs might be considered a cause of uterine rupture but Hopkins and Amor (1964) were unhappy to accept this suggestion. They noted that whilst vigorous foetal movements were frequently encountered, uterine rupture seldom occurred. Conversely uterine rupture might be found where no vigorous foetal movement had been observed. The gravid uterus is undoubtedly vulnerable to injury and in a detailed anatomical and clinical study de Bruin (1904) considered that the ventral wall of the uterus just over the pelvic brim was most susceptible to rupture. Rupture at this point would be most likely to provoke serious haemorrhage since much vascular tissue was present in this area compared with the dorsal wall. Studies by Smythe (1942) who used injection of dye under

pressure into post mortem specimens, confirmed that the ventral surface of the uterus was indeed the most vulnerable. Many accounts of dorsal surface rupture have however been reported in the literature and de Bruis (1904) observed, that although haemorrhage was less likely at that point, peritonitis might well be a complication.

Rupture of the uterus will in most cases result in cessation of myometrial contraction. Following rupture the foetus may remain in the uterus or pass wholly or partially into the peritoneal cavity. In the latter event, should myometrial contractions resume, they will be unable to aid foetal expulsion. Pearson and Denny (1975) considered that once a foetus had passed into the peritoneal cavity abdominal straining would also cease. The initial signs of uterine rupture may resemble those of a simple uterine inertia but if peritonitis or haemorrhage occur as a result of rupture more serious and generalised symptoms may appear.

In some cases a suspected cause of uterine rupture may be apparent. Armfield (1930) recorded a case in which a cow had attempted to jump a fence and had fallen five days before she was observed to go into ineffectual labour. Other causes have been suspected including damage during transport (Buckler, 1938), injury by other cattle (Arthur and Gray, 1960) or collision with a car (Lamont and Young, 1962). Occasionally uterine rupture may be complicated by other injury such as vaginal laceration (James, 1882). Gross distension of the uterus with twin pregnancy was a possible cause of uterine rupture in cases of dystocia reported by Grimal (1903) and by Carbury (1924b). The grossly mishapen structure of the schistomus reflexus monster was found to be complicated by uterine rupture in cases recorded by Lomas (1896b), Gray (1937), Turnbull (1941), Wheat (1948) and Steele and Simms (1956). Heijbel (1932) reported a case of an eight-year-old cow in which an ankylosed and rachitic foetus had penetrated the dorsal uterine wall and caused death of the cow from peritonitis.

In a number of cases uterine rupture has been reported in late gestation when the dam has appeared to go into premature labour. Lloyd (1913), Brown (1947), Arthur and Jenner (1960), and Blenkhorn and Adams (1974) all recorded cases in which the patient showed depression and dullness and which were found on laparotomy or post

mortem examination to have suffered uterine rupture. In other cases birth overdue by two to fourteen days has been reported in which uterine rupture had occurred with resultant failure of foetal delivery (McAleer, 1924; Hall and Heath, 1938; Georgi, 1954; Pascoe, 1968). Foetal death and decomposition had occurred in three cases but in Georgi's case, two days overdue, the foetus was found to be alive. Robinson (1930), Prather (1954) and Wilson (1959) each reported one case of cows which had shown signs of severe illness at the time of calving. In the last two cases traumatic reticulitis was suspected from the observed symptoms and laparotomy performed revealing uterine rupture with passage of the foetus into the peritoneal cavity. Remarkably in Prather's case the foetus was found to be alive.

In a very unusual case of suspected uterine rupture, Bradley (1960) reported gross abdominal distension in a cow which he attributed to pneumo-peritoneum. Large amounts of fluid and gas were thought to be present in the abdomen and rupture of the uterus was expected. However at laparotomy the uterus was found to be intact but the foetal fluids were almost completely missing. A living calf was delivered by caesarean section and it was suspected that a small hole in the uterus, albeit invisible, had allowed escape of fluids to take place and air had been aspirated by the cervix into the uterus and on to the peritoneal cavity. Brown (1947) recorded a case in which a $2\frac{1}{2}$ -year-old heifer was presented having been dull and believed to have been suffering from indigestion for a period of five days. A foul discharge from the vagina was noticed and putrid foetal membranes were withdrawn. A tear in the floor of the left uterine horn was discovered and following slaughter of the cow, a decaying foetus was found in the abdomen.

Robertson (1926) was unable to deliver the foetus of an Aberdeen Angus heifer although he could, with difficulty, palpate its hind limbs through a tear in the right horn of the uterus. The heifer was slaughtered and Robertson reported that the foetus was enclosed in the right fallopian tube. It is possible that his post mortem was not detailed enough to confirm the true situation. Occasionally the absence of a foetus in the uterus may cause the farmer to consider that the cow has calved and the calf has been lost. Hutchins and Blood (1955) described such a case in which, although the owner

suspected the cow had calved, no foetus had been found. The cow was dull, pyrexia and dehydrated. Abdominal ballottement revealed a foetus well forward in the abdomen just behind the xiphoid process of the sternum. At laparotomy the presence of a dead foetus was confirmed and an eighteen-inch tear was found along the lateral aspect of the right uterine horn. The cow was reported to have recovered well from surgery.

The clinical signs of spontaneous uterine rupture are varied and may be difficult to interpret as, in the case of uncomplicated uterine inertia, preparatory stages of birth may have proceeded normally to be followed by a cessation of parturient activity. Vaginal examination may reveal an empty uterus fully involuted but possibly containing some placental remnants. Examination of the uterus, if this is possible, may reveal a tear in one part of the wall. Rectal examination may confirm that the uterus has involuted and in some cases may allow foetal ballottement. When the presence of a foetus free in the abdomen is suspected laparotomy must be performed to confirm the diagnosis, allow assessment of the uterine damage and to remove the foetus. Where peritonitis has developed signs of general ill health and discomfort will be present and must be accompanied by a grave prognosis. In more chronic cases, extensive adhesions can make surgery impractical.

Uterine rupture arising during the correction and delivery of other forms of bovine dystocia will be discussed later in this thesis.

CHAPTER EIGHT

DYSTOCIA CAUSED BY OBSTRUCTION OF THE BIRTH CANAL

Cox (1877a, b) in a series of lectures entitled 'Veterinary Obstetrics' in which he discussed the causes of bovine dystocia considered that the birth canal of the cow might be obstructed by uterine torsion, adhesions of the vaginal wall, vaginal tumours, pelvic damage or constriction of the vulva. Normally any obstruction involves either bony or soft tissues but both Voelker (1967) and Williams (1968) warned that animals which were bred at an excessively early age might suffer dystocia caused both by a small bony pelvis and also under-developed soft tissue structures. Induction of birth in cattle has been employed to terminate unwanted pregnancy and in the treatment of misalliance. In some cases the attempt to avoid dystocia due to foetal oversize by premature induction of birth has resulted in dystocia caused by failure of the birth canal to dilate and relax sufficiently to allow passage of the foetus (Day, 1979).

The authors of most veterinary text books have considered obstruction of the birth canal under the separate headings of bony and soft tissue abnormality (de Bruin, 1901; Williams, 1933; Roberts, 1971; Arthur et al., 1982) and the same method of classification will be employed in this thesis.

Bony tissue obstructions

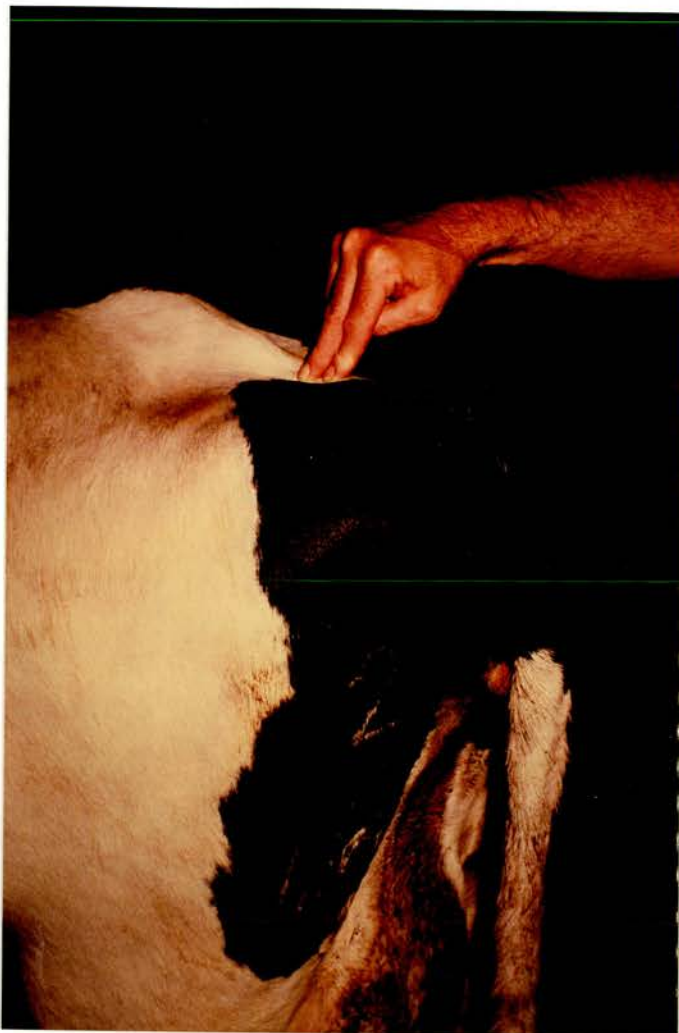
The bony pelvis of the cow is a robust structure and is unlikely to suffer fracture although Richardson (1901) suggested that the ilial shaft was liable to fracture of the cow fell. Cox (1978) considered that the sturdy structure of the pelvis would make fracture most unlikely but should a fracture of one part occur, what he called the box-like rigidity of the pelvis would be lost and further fracture would be likely. He described a case of pelvic fracture in a thirteen-year-old Ayrshire cow caused by a fall on ice. Labour was inhibited both by obstruction of the birth canal and also by pain which occurred when the cow attempted to strain. The calf was

delivered by traction but the cow failed to get up. Cox advised that the possibility of pelvic fracture should always be considered in 'downer cows' and in any older cow suffering dystocia.

Other cases of pelvic fracture requiring either embryotomy or caesarean section were described by Anon (1902), Burke (1940), Ross (1945) and Muir (1946b). Parkinson (1974) described two further cases in which pelvic distortion prevented delivery of the calf per vaginam. In one case pelvic damage, possibly fracture, had been caused by application of excessive traction at a previous calving and in the other case the cow had suffered a damaged pelvis following collision with a car. Rachitic deformity was most unlikely to occur in the cow whose pelvis was essentially non weight bearing according to Williams (1943).

Richardson (1901) and also O'Farrell and Crowley (1974) recommended induction of birth in cases in which pelvic fracture was present. In cases of recent fracture, or unless the foetus is so small that it can easily be passed through the damaged pelvis, such induction may not be wise and in most cases caesarean section at term may be the best course of action.

The breeding of immature animals may give rise to dystocia caused by a small pelvis (Williams, 1968, Knight, 1969) failing to allow passage of the fully developed calf. Kingman (1957) in a paper entitled 'Dwarfism and obstetrical problems' found that pelvic abnormalities might occur in dwarf animals. The term 'dwarf' was loosely used and appeared to refer to non-achondroplastic but small animals. Foetal oversize may complicate cases of small bony pelvis and exacerbate any dystocia occurring. Ménissier (1980) in a discussion of double muscled calves noted that the double muscled mothers of such animals might have smaller bony pelvises than their non-double muscled counterparts. A further type of dystocia caused by abnormality of the bony part of the birth canal was described by Hickman (1882). He was called to a primiparous heifer in which a bony structure resulting from fracture of the coccygeal vertebrae was projecting down into the birth canal. The foetus was unable to pass the constricted space between the maternal pubis and the coccygeal vertebrae above. The author (Jackson, unpublished data) encountered a similar case involving a second parity Friesian cow which is illustrated below.

PLATE 15

Obstruction of the birth canal in a Friesian cow caused by depression of the coccygeal vertebrae

In this case caesarean section was required to deliver the foetus. No evidence of fracture was found in this animal but the coccygeal vertebrae deviated ventrally obstructing the birth canal. Although no detailed history was available the cow was reported to have delivered her first calf without difficulty.

Although caesarean section, or if the foetus is dead embryotomy, is normally used to treat such cases Harsch and Hanks (1971) and Vernhet (1977) recommended the technique of symphysiotomy. An obstetrical chisel was used under local anaesthesia to divide the pubic symphysis in young parturient cattle thus allowing dilation of

the birth canal. The authors claimed that animals made good recovery and were able to rise and walk after the procedure. Sloss and Dufty (1980) who also described the technique advised that the animal's legs be hobbled following operation to avoid damage due to excessive abduction during the healing process.

Soft tissue obstruction

Soft tissue obstruction of the birth canal may be caused by the presence of (a) an abnormal structure occluding the patency of the canal, (b) by failure of the canal to dilate, or (c) by displacement of part of the canal thus occluding its lumen.

(a) Obstruction of the Birth Canal caused by Abnormal Structures

(i) Hymen-like membrane occluding the vagina

There have been a number of reports of this condition in the literature; many under the title 'White Heifer Disease' as the problem has been encountered chiefly in white or roan Shorthorn cattle. Zinnbauer (1929) who investigated the hymen in various domestic species noted that a hymen was not normally present in the vagina of the domestic cow, although a circular narrowing may be found in the vagina just anterior to the external urethral orifice. In a detailed anatomical study Scorgie and Ottaway (1942) concluded 'normally no complete hymen exists in cattle' but pointed out that small projections - probably hymenal vestiges were to be found at the junction of the vagina and vulva. These were called carunculae myrtiformes and might appear as a circular fold in the vagina of heifers. The authors considered that the hymenal obstruction seen in some white heifers was an hereditary condition and was not related to the carunculae myrtiformes. These authors also warned that the annular rings, some six in number and about one inch apart, to be found in the vaginal walls of some cattle might be confused with hymenal tissue.

The hymenal abnormality seen in white heifers has been recognised for many years. Wood (1899) described a case involving a white Shorthorn heifer in which the vagina appeared totally obstructed just caudal to the cervix. The membrane was thin and easily penetrated and delivery of the calf was achieved with ease. He also described a

case in an aged white Shorthorn cow in which he found a similar membrane. This cow had calved unaided on several occasions and it is possible that the abnormality reported was in fact fibrosis or adhesion of the vaginal wall resulting from previous injury. Undoubtedly since fertilisation has occurred, the obstruction cannot have been total and Wilson (1899) described a similar case in a cross-bred Shorthorn heifer in which the hymen had a small aperture.

Many cases cause concern to persons offering lay assistance and Campbell (1925) when called to a parturient white heifer was told by her owner that there was 'no road into her'. In this case the hymen was quite thick and Campbell had to use a trocar and cannula to pierce it before delivery of the calf could be achieved. In other cases he had successfully used a thatch peg. Stinson (1925) warned that despite breaking down the membranes considerable traction might be needed to deliver the foetus in such cases. In some cases the hymen may be too thick to allow puncture and breakdown and Curtis (1937) reported a successful caesarean section of a white Shorthorn heifer in which the hymen was estimated to be two inches thick and completely impenetrable. The same author (Curtis, 1939a) reported a similar case which had been neglected and which attempted labour had been going on for three days. Caesarean section under chloroform anaesthesia was successfully performed although the calf was dead. Curtis considered that the term 'White Heifer Disease' might be somewhat misleading and believed that there were two conditions which might be seen in both white and other heifers. In one category a true hymen persisted, but in the other obstruction to the vagina was caused by healed and fibrosed utero-vaginal abscesses. In these latter cases no hymen was present.

In some cases once the hymen has been ruptured foetal delivery will follow without aid but in other cases traction may be required. Edwards and Phillips (1941) encountered a case of dystocia involving a roan Shorthorn heifer in which a hymen-like obstruction occluded the vagina. It was broken down with ease and the animal was left to await progress. Six hours later a large foetus weighing 102 lbs was delivered by moderate traction. Although the case report provided little detail it is possible that had the calf been delivered after the hymen had been ruptured, it might have been born alive. Delay in

the treatment of cases of vaginal obstruction may lead to complications and Tutt (1943a) described the case of a parturient white Shorthorn heifer in which the dorsal wall of the vagina had ruptured allowing the foetal head and fore limbs to pass into the recto-vaginal inter-space. The foetus was delivered following epidural anaesthesia and repulsion and although the author reported that no other abnormality was seen, it is possible that there may have been a hymenal obstruction preventing delivery and that the expulsive forces of the cow caused damage to the roof of the vagina. Tutt did not further treat his case which died three days later.

Spriggs (1946), like Curtis (1939a), considered that the term 'White Heifer Disease' was unsuitable and reported his findings following examination of the genital tracts of ten affected animals. He considered the condition to be a gross genital hypoplasia due to arrested development of the Muellerian ducts. Three forms of the condition might be seen: (a) absence of the anterior vagina, cervix, uterine body but with cystic uterine horns being present, (b) uterus unicornis - with cystic enlargement of the single uterine horn with or without a vaginal hymen, (c) hymen obstruction of the vagina. Spriggs considered the condition to be hereditary and self-limiting. He suggested that it should be differentiated from cases in which a hymen obstructed the birth canal at parturition. It is clear from the literature that many other authors do not agree with Spriggs' view. The numerous reports of White Heifer Disease in which pregnancy has occurred, some of which have been discussed above, suggest that some such animals, probably in Spriggs' category (c), do in fact breed if the hymen constriction is such that it can be dypassed at the time of fertilisation. Gilmore (1949) also expressed doubts of the usage of the term 'White Heifer Disease' noting that it was a non-descriptive term and referred to a number of different anatomical abnormalities. He considered that on rare occasions such animals did in fact conceive and problems might occur at parturition.

(ii) Muellerian duct remnants in the region of the cervix

Vertical bands of tissue in the anterior vagina of maiden heifers were reported by Scorgie and Ottaway (1942) having been detected at the time of artificial insemination. The bands were severed

prophylactically to avoid dystocia and were believed to have been Muellerian duct remnants. In a slaughterhouse survey of 1009 bovine genital tracts, Abusineina (1970) found that two per cent of cases showed some signs of cervical abnormality. Of those showing defects, 75 per cent were cases of what appeared to be 'double os uteri externa'. Careful examination revealed that the cervix was in fact normal but a perpendicular band which appeared to divide the cervix ran across the lumen of the vagina immediately caudal to the external uterine os. In the survey Abusineina found evidence of what he considered might have been a case of dystocia. In one cow showing Muellerian duct remnants a macerated foetus was present in the uterus. It had possibly died following obstruction of its birth at the time of parturition. The duct remnants did not always cause dystocia as in three specimens evidence of previous pregnancy with no foetal remnants was discovered. An earlier paper by Spriggs (1945) had reported similar findings. Accidental damage to the anterior vagina may produce lesions somewhat similar to those associated with Muellerian duct remnants and in some reports insufficient detail is given to enable the reader to be certain exactly what caused the obstruction. Horsburgh (1846a) described a case of dystocia involving twin calves in which the os uteri was closed by a stricture preventing foetal delivery. It is not clear from this paper exactly what this was but it may well have been a Muellerian duct remnant. Reports of vaginal obstruction by Steel (1879), Pack (1921) and Allen-Potts (1941) also failed to give sufficient detail to enable an exact diagnosis of the cause to be made.

(iii) Neoplasia of the birth canal

Obstruction of the birth canal caused by cancerous growth in the cervix, uterus and vagina has been reported. Corbet (1834) was called to a case in which a large polyp weighing 84 lbs obstructed the birth canal just anterior to the cervix. Delivery proved impossible and at post mortem the tissue was noticed to be very vascular but no histological studies were carried out. Cooper (1930) considered uterine tumours a 'not uncommon' cause of dystocia and reported a case involving a Shorthorn cow. The tumour originated in the dorsal uterine wall and passed into the vagina each time the cow strained,

thus preventing passage of the calf. Administration of epidural anaesthesia allowed the calf to be manipulated past the tumour which was later removed.

Bowhill (1891), Waghorne (1907) and Caldwell (1933b) all described cases of dystocia caused by cancerous growths originating in the cervical region of the birth canal. In the first two cases manual delivery was possible and the lesion was removed later. In the third case the tumour, believed to be a fibroma, was removed under epidural anaesthesia before foetal delivery. Vaginal fibromata causing dystocia were also reported by Bibbey (1915) and Roberts (1924). Wyssman (1946) noted that non-neoplastic but tumour-like vaginal cysts, which were probably embryonic remnants, were sometimes found in the vaginal wall of cattle and if large might give rise to obstructive dystocia.

(b) Obstruction of the Birth Canal caused by failure of parts to dilate

(i) Vulval and vaginal constriction

Constriction of the vulva despite relaxation of the remainder of the soft tissues of the birth canal can give rise to dystocia. Cox (1877a & b) noted the problem as a cause of dystocia and Arthur (1966) considered that Friesian heifers might be particularly susceptible. The problem may be caused by a failure of the vulva to dilate or by the presence of scar tissue in the vulval lips. Before dehorning of cattle became widespread the author (Jackson, unpublished data) saw a number of cases in which trauma, caused by horning injury, resulted in problems at calving time. Dufty (1972) found vulvo-vaginal constriction a problem in a herd of closely confined Hereford cattle and attributed the problem to excessive sympathetic nerve stimulation. Johnston and Sloss (1967) noticed a seasonal problem in Aberdeen Angus cattle caused by fat deposition around the vulva following grazing of lush pastures. Gentle manual dilation may enable foetal delivery to occur but in some cases episiotomy may be required to prevent rupture of the perineum and establishment of a recto-vaginal fistula.

Swarbrick (1964) noted the widespread use of episiotomy in human obstetrics and that it was rarely employed in animals. He considered

that the technique, which was also useful in some cases of foetal oversize, was best carried out under epidural anaesthesia. An incision was made in the lateral wall of the vulva some two-thirds of the way down. The incision passed in a dorsolateral direction medial to the ischial tuberosity. In some cases Swarbrick noted that the incision might only involve the skin but in other cases it might be necessary to incise the mucous membrane also. Freiermuth (1948) was also a protagonist of episiotomy, especially in first calf heifers and considered it allowed better access to manipulate the foetus and to perform embryotomy.

Arthur (1966) considered that on occasion bilateral episiotomy might be necessary. Hudson (1980) did not consider that an epidural was always necessary, particularly when the tissues were stretched during delivery. Suturing however might require anaesthesia. Johnston and Sloss (1967) working with beef cattle in Western Australia found that episiotomy was required with or without cervicotomy in only 0.6 per cent of cases.

An unusual and dangerous method of enlarging the birth canal was described by Jones (1857) who was a veterinary student. Division of the sacro-ischiatic ligament was described using a pointed bistoury to cut the ligament through a small puncture wound, made with a trocar between the ischio-rectal fascia and the sacro-ischiatic ligament. Jones found the technique very useful and wondered if it might be used in human obstetrics.

Recto-vaginal constriction in Jersey cattle, believed to be caused by a single autosomal recessive gene, was reported by Leipold et al. (1981). A tight constriction was present at the vulvo-vaginal junction necessitating caesarean section at birth. Pathological studies by McGhee and Leipold (1982) revealed that the constriction was caused by tight non-elastic fibrous bands encircling the vulva and rectum. It was suggested that heifers should be checked for the condition by rectal and vaginal examination before breeding.

Conisbee (1938) was called to a case of dystocia in a twelve-year-old Jersey cow. Obstruction of the birth canal was attributed to a mass attached to the roof and wall of the uterus. The calf was manipulated past the mass which, on later examination, appeared to be a large haematoma. A similar case was described by Bolton (1948). A

perivaginal haematoma was the cause of obstructive dystocia in a case reported by Williams (1921).

Obstruction of the birth canal may also be caused by displacement or distension of the urinary bladder. The bladder may either prolapse (i.e. evert) or may pass into the vagina through a defect in the vaginal wall. Arthur et al. (1982) used the term vaginal cysto-coele to describe both types of bladder abnormality. Urethral obstruction may occur with the enlarged and displaced bladder completely blocking the vagina. Cartwright (1846d) who described both prolapse and herniation of the bladder warned that the bladder might easily be mistaken for the foetal membranes distended with fluid with the possibility of inadvertent rupture.

Bond (1918), Duff (1974), Frost (1974) and Leslie (1974) all described cases in which the bladder had obliterated the birth canal but in none of these was it clear whether the bladder was prolapsed or herniated. Treatment was by manual delivery of the calf after replacing the bladder with or without drainage of that organ. Displacement of the bladder retro-peritoneally alongside the vagina was reported in a parturient cow by Cameron (1962). The cow, a five-year-old Shorthorn, delivered twin calves with some assistance. Following delivery straining continued and the displaced bladder was discovered on vaginal examination. It was manually pushed forward over the pelvic brim whereupon urination immediately occurred.

(ii) Incomplete dilatation of the cervix

Failure of the cervix to dilate at the commencement of parturition is an important cause of bovine dystocia and one that can be most difficult to treat. Sloss and Dufty (1980) noted that up to ten per cent of dystocia cases might be attributed to this problem. Harvey (1922) described the cervix as 'an exceedingly troublesome organ for the practitioner'. Bitter experience of the difficulties of dealing with cervical problems in practice led Hunter (1888) to warn colleagues of the dangers of getting involved in such cases noting 'the professional man needs to discriminate before undertaking treatment and he seldom gains much honour thereby'.

The importance of knowledge of the normal and abnormal cervix was stressed by Kingman (1956) who considered such information

essential if sensible clinical judgements were to be made. He concluded that the cervix was resistant to injury and had good recuperative powers but was liable to congestion and lymph stasis. This might in turn lead to engorgement, hypertrophy, oedema and fibrosis. Williams (1943) questioned the true incidence of alleged cervical problems and considered that most were really caused by myometrial and other problems which failed to contribute to the normal dilation process. Macgillivray (1872) considered that cervical constriction might either be a temporary spasm in which case the prognosis was good, or a total stricture where the prognosis was poor. He considered that the six annular rings present in the cervical wall were abnormal but later studies have shown that they are normal (Fitzpatrick, 1957; Devine, personal communication). Williams (1887), principal of the New Edinburgh Veterinary College, recognised three categories of cervical abnormality: (i) partial dilation, (ii) total closure where excessive myometrial contraction might occur with no dilation of the cervix, (iii) closure caused by chronic fibrosis - 'scirrhus os'.

Sloss and Dufty (1980) noted that the bovine cervix was more muscular, fibrous and tightly closed than that of other species. These properties made the structure a potential cause of severe dystocia when failure to dilate occurred. Silva (1979) had noted a relationship between the degree of cervical dilation and the plasma oestrogen levels whilst Sloss and Dufty (1980) considered failure of the cervix to dilate might result from an insufficiency of oestrogen and relaxin production or an abnormality of the autonomic nervous system. Excessive sympathetic activity might cause a reduction of myometrial tone and although passive cervical dilation might occur, active dilation as a result of muscular activity would not. Excessive parasympathetic activity might produce a high myometrial tone and a failure of dilation of the cervix. Other causes of failure of cervical dilation mentioned by Sloss and Dufty (1980) were ischaemia associated with uterine torsion, hypo-calcaemia and fibrosis associated with previous trauma. Sloss and Dufty suggested that four gradations of cervical closure might be clinically recognised. Grade I was the mildest form and dilation was almost complete, obstructing only the widest part of the foetal body. Grade IV represented total occlusion

of the canal, with grades two and three representing intermediate stages.

A number of authors have suggested that the foetus in breech presentation might contribute to the failure of cervical dilation and Rutter (1976) noted the occurrence of the problem in two generations of one line of cattle.

Treatment of incomplete cervical dilation may present problems and is complicated by the difficulty of predicting the changes which may occur in the cervix within the foreseeable future. As Rosenberger (1979) observed 'it has to be determined whether the opening process is still not complete or if the narrowness is permanent'. In cases in which further dilation might be expected to occur, the foetus was normally alive and the cervical mucosa elastic and slippery. If on the other hand the foetus was dead and the birth canal dry, cervical dilation was unlikely to occur.

Complications caused by lay interference may also be present and Younghusband (1851) described a case which was so severely damaged by persons 'using all their means to get the calf away' that it had to be destroyed. Harrison (1887) advocated 'great care in approach' to such cases and he considered that many were not in fact ready to calve even though straining was sometimes seen. He suggested administering chloral hydrate to allay straining and then 'leave nature to make her own preparations'. Heatley (1932a) advised that the practitioner should not delay too long and recalled a case which he had left for twenty-four hours whilst awaiting cervical dilation. On return he found that the cervix had opened, the calf was dead and emphysematous and the cow was extremely ill.

In some cases manual dilation may be possible and Cartwright (1830) recalled a case in which the cervix of the cow dilated after two hours of gentle manipulation. Hunter (1888) advocated that the cow should be given six to seven quarts of London Stout and vaginal lubrication, which might be followed in some three days by cervical dilation.

West (1876) described using a human appliance, Dr. Barnes' India Rubber Bag, in a cow which was three months past her alleged calving date. The appliance was inflated by means of a bicycle pump and was introduced into the cervix with a whalebone probe. Fleming (1877)

also mentioned this device and a number of others including the technique of uterine douching which he thought might be effective in really difficult cases. Fleming also noted that Swiss veterinarians had forcibly dilated the bovine cervix using fire tongs but the damage caused had required fifteen days careful post-operative care to soothe the damaged tissues. A more cautious approach was advocated for ovine ring womb, with possible application in cattle, by Turner (1973) who used a vibrating probe to achieve cervical dilation. Drug therapy has been advocated by some and Hall (1855), Fleming (1877) and Richardson (1901) noted the popularity of local application of *bella donna* to the cervix. Craik (1906) advised trying the drug before resorting to more drastic measures. Pituitary extract and other ecbolics might stimulate uterine contraction with dilation of the cervix (Anon., 1913a) but the danger of uterine rupture should always be borne in mind.

In the days before caesarean section became generally used, the technique of vaginal hysterotomy or cervicotomy was widely practised in Britain and on the Continent. Cruciate incisions were made in the cervix using a small finger knife. Harvard (1673) described the operation, noting that he considered this was better than opening the uterus via a flank incision. Tait (1833) successfully performed the operation in a cow which according to its owner had 'no passage to calve'. Horsborough (1840) who practised in Dalkeith encountered the problem of a closed cervix quite frequently and found vaginal hysterotomy a useful procedure. He made three incisions in the cervix, one dorsally and one laterally on either side. Unlike some other authors he never made a ventral incision in case the bladder was damaged. He advised that the operation should be carried out early in labour and recorded the death of a cow in which the operation was delayed until labour had been in progress for two days.

Macgillivray (1872) found the operation easy to perform if the cervix was partially dilated and reported that he had enjoyed overall success with the technique although in some cases death from septicaemia and haemorrhage had occurred. Other early descriptions of the operation performed with varying degrees of success included those of Bonnet (1848), Cox (1877a, b), Greene (1884), Freer (1894), Bruschi (1900) and Penhale (1906). Following vaginal hysterotomy

traction was sometimes also required (Hall, 1855). Wilkinson (1926) recorded his use of the operation in a second calf cow which had suffered cervical laceration at her first birth. Despite dilation of the birth canal embryotomy was still required to deliver the calf.

In the author's view vaginal hysterotomy is a dangerous procedure and has no place in modern veterinary obstetrics. When cervical constriction has failed to respond to manipulative or conservative treatment, caesarean section is probably the method of choice to deliver the foetus. The local application of prostaglandin E to the cervix, which is used to promote cervical dilation in women, has not been evaluated in cattle. The use of smooth muscle spasmolytics is of doubtful value.

(c) Obstruction caused by displacement of part of the Birth Canal

The most important form of displacement of the birth canal is that caused by torsion of the gravid uterus. Sloss and Dufty (1980) noted that the incidence of uterine torsion varied from country to country ranging from one to three per cent of all dystocias in Australia to 12.5 per cent among cattle in Switzerland. In Britain the incidence had been estimated at four to five per cent (Iutt, 1944; Morten and Cox, 1968). The incidence of torsion of the uterus has been reported as being higher in cows than in heifers and being more frequently seen in the Spring following the turning out of housed cattle (Sloss and Dufty, 1980). Although the condition occurs only once in most cases Pratt (1902) reported the case of a cow which had suffered uterine torsion twice with her first and fourth calve, in both cases the torsion being corrected by rolling. Williams (1943) considered that the incidence of uterine torsion was higher than was generally realised. In his view many cases, diagnosed as calves in ventral or lateral malposition, were in fact cases of mild uterine torsion. According to Roberts (1971) cases of 180° torsion were found quite frequently during pregnancy diagnosis without apparently causing harm to the animal. Such cases undoubtedly undergo self resolution long before the onset of parturition.

Fleming (1877) commented on the fact that few cases of uterine torsion had been reported prior to the year 1850. Many veterinarians were reluctant to diagnose the problem although amateur obstetricians

had long recognised the condition. It is possible that the condition was in fact less common at the time of Fleming's writing as conditions of husbandry were probably less intense. Prinz (1838) reported the successful rolling of a cow to correct uterine torsion in Dresden and Fleming (1877) recognised many other reports of the condition from 1850 onwards. Undoubtedly Fleming's book was of great value in publicising the problem of uterine torsion to British practitioners. Cunningham (1886) who practised in Slateford, Edinburgh had found uterine torsion a great problem and having read Fleming's work resolved to attempt rolling the next case that he encountered. He did so successfully and delivered a living calf. As the case was dealt with at New Year Cunningham remarked 'we toasted Dr. Fleming and his continental friends in Scotch New Year fashion'. Cartwright (1850a) noted that many cases were left to die and suggested that qualified veterinarians should attempt to deal with the problem either by laparotomy or by rolling.

Despite the publicity given to the problem by Fleming (1877) some veterinarians still did not attempt to treat affected animals. Knowles (1901) having diagnosed uterine torsion left his patient until the next day before attempting treatment in the hope that self-resolution would take place. The calf had died on his return and the cow died of pneumonia one week later. Cunningham (1901) expressed himself amazed that Knowles was unaware of the need for immediate action and mentioned the published work of Fleming and other authors should he need guidance.

Torsion of the uterus occurs much more frequently in cows than in females of the other domestic species. The bovine uterus has been recognised as basically unstable due to certain anatomical features. Sloss and Dufty (1980), summarising the work of others, noted that the bovine uterus was supported by broad ligaments which, unlike those of other species, were attached to the ventral surface of the uterine body, thus contributing to its instability. As pregnancy developed the gravid organ fell beyond the pelvic inlet being supported only by other abdominal organs. There was also a tendency for the large pregnant horn of the uterus to roll over the smaller non gravid horn. Gloor (1973), reviewing 102 caesarean sections performed for intractable uterine torsion, considered that torsion to the left by a

right horn pregnancy was particularly likely to occur if the uterus had passed outside the omentum and was no longer supported by it.

A number of exciting factors have been suggested as likely to cause the unstable uterus to twist. Lack of exercise, with resultant slackening of abdominal musculature, was suggested by a number of authors cited by Sloss and Dufty (1980). Sudden vigorous exercise such as being chased by dogs or falling were suggested by Cartwright (1850a), Chambon (1861) and Penhale (1906). Patrick (1901), Richardson (1901) and Armfeld (1930) suggested that jumping over a hedge or ditch might have provoked uterine inertia in cases which they attended. Two historically interesting causes were suggested by Fleming (1877) who warned that uterine torsion might occur following casting of heavily pregnant cows to be shod or using such an animal for heavy draught or farm work.

Lack of uterine tone, possibly associated with hypocalcaemia, might predispose to uterine torsion according to Lewis (1929) and Sloss and Dufty (1980). Excessive foetal movement, 'foetal friskiness', was suggested by both Hynes (1933) and Standley (1943) as being liable to provoke uterine torsion, especially when there was a reduced quantity of foetal fluids. Calf weight was considered an important contributory factor by Franz (1964) who recorded a highly significant difference in the weight of calves born following uterine torsion (41.86 kg) compared with the weight of calves delivered without problem (35.44 kg). Similar figures were quoted by Wright (1953) and Pearson (1971). Miller (1894) suggested that a grossly enlarged left kidney might have been responsible for uterine torsion in the case which he encountered in practice while Smith (1963) suspected a displaced abomasum of having a somewhat similar contribution.

Torsion of the uterus may occur either in a clockwise or an anticlockwise direction. Arthur et al. (1982) considered that the consensus view was that approximately 75 per cent of cases of uterine torsion were in an anticlockwise direction. The degree of torsion varies considerably and Sloss and Dufty (1980) citing work of Frerking et al. (1975) noted that ten per cent of cases involved a twist of 90° , 52 per cent 180° , 28 per cent 290° , 9 per cent 360° and one per cent had a twist greater than 360° .

Most cases of uterine torsion occur during first or early second stage labour and the birth canal is actually twisted caudal to the cervix. Once a twist is corrected, in some but not all cases, the cervix will be found to be open and birth will be possible. In other cases, usually more serious but less common, torsion occurs before parturition has begun and the torsion in these cases is usually anterior to the cervix. Pearson (1971) reported on 168 cases seen at Bristol Veterinary School. The majority were parturient cases and caudal to the cervix.

Torsion of the uterus occurring before parturition and anterior to the cervix has been described as causing violent colicky pain with death following if treatment is not proceeded with immediately (Ernes, 1870; Bennett, 1872; Cunningham, 1899; Zaruba, 1934; Morrow, 1938; Arthur and Jenner, 1960; Pearson, 1973). In a case reported by Bradley (1961) sudden death attributed to uterine torsion occurred after the animal had been seen to gad around her field. In some cases abdominal distension has been described (Tribouillard, 1926). It may be possible to diagnose the condition by palpating (per rectum) the displaced uterine arteries and the twisted uterus just anterior to the cervix. Vaginal examination does not normally show evidence of the spiral mucosal folds characteristic of the parturient, post-cervical torsion (Cunningham, 1899; Sloss and Dufty, 1980). Pearson (1973) has recommended that immediate treatment by laparotomy should be carried out in pre-parturient cases. Dauvois (1932b), reported that he found epidural anaesthesia facilitated replacement of the uterus by rolling in such cases. He carried out a rectal examination afterwards to check that the uterus had returned to its normal position.

The more common form of uterine torsion, parturient and post-cervical, has a number of features which the authors of most obstetrical text-books have described (Fleming, 1877; Williams, 1943; Roberts, 1971; Sloss and Dufty, 1980; Arthur et al., 1982). The affected animal may show signs of mild uneasiness (Parker, 1891; Standley, 1943; Pearson, 1971). In some cases the cow was noticed to be standing with her lumbo-sacral region depressed (Collett, 1922; Pearson, 1971). McIntosh (1894) noted that in some cases jerking movements of the loins were seen and the tail was raised and lowered.

The vulva may appear to be puckered and pulled in (Chambon, 1861; McIntosh, 1894; Weighton, 1944). Chambon (1861) however warned that sinking of the vulva might also be seen in normal cows which were slightly overweight at calving time. Ernes (1870) noted that the rectum might also appear to be pulled in. On rectal examination the twisted vagina might be palpated and Thompson (1896) likened it to a twisted walking stick. Displaced and tense uterine arteries were palpable through the rectal wall in some cases (Parker, 1891).

Diagnosis can normally be confirmed by vaginal examination. The cervix is not normally palpable in torsion cases and the hand passes into a cone-shaped constriction in the anterior vagina. Folds of mucous membrane spiral in the direction of the twist. Ernes (1870) wrote that he considered this finding to be pathognomonic of uterine torsion. Working with European cattle in South Africa, Kind (1940) commented that in his experience spiralling of the vagina was not always present and that a more reliable factor was the dislocation and displacement of the broad ligaments palpable through the vaginal wall.

In cases where the torsion is less than 180° it may be possible to pass a hand via the twisted vagina into the uterus. Cunningham (1886) described the sensation thus 'forcing your way in, your hand is guided to the off or right side and your fingers go slightly outward and then downwards and forwards and inwards through a soft yielding opening and as the hand passes through it receives lastly a gentle upward and outward turning and as you straighten your arm to its original position you find that you have gone through a corkscrew twist that now grips and encircles your wrist while underneath and in front of your hand is the calf'.

The prognosis of uterine torsion depended on the severity and duration of the condition according to Sloss and Dufty (1980). The blood supply to the uterus tended to be compressed by the torsion which might lead to necrosis and rupture of the uterus. According to these authors a maternal mortality of seven to thirteen per cent should be expected, whilst approximately 50 per cent of the calves would die before delivery.

Parturient uterine torsion may be treated in a number of ways: (i) vaginal manipulation, (ii) external manipulation, (iii) rolling or

(iv) laparotomy. Despite the various methods available, it is clear from the literature that some authors have very firm views on the correct procedure. Margaron (1929), Kind (1939), Auld (1947) firmly believed that rolling was the most satisfactory treatment. Scott (1958) estimated that in twenty years' practice he had seen 100 cases and all but two were corrected by internal manipulation. Occasionally authors have admitted changing their minds. Williams (1929) after rolling cows for twenty years abandoned the technique for one of controlled traction.

Internal manipulation, termed 'manual detorsion per vaginam' by Sloss and Dufty (1980) is perhaps the simplest method and arguably the method of choice if it is possible to pass the hand through the twisted vagina into the uterus to make contact with the calf. Cumming (1934) considered this possible if the twist was less than 180° whilst Sloss and Dufty (1980) suggested it might be possible in twists of up to 270° . Morrow (1938) found that repulsion of the calf often caused it to struggle violently, turning over and correcting the uterine torsion at the same time. Lloyd (1958), Scott (1958) and Sloss and Dufty (1980) described their technique of manual detorsion. They suggested inserting the lubricated hand into the vagina, following the obstruction into the uterus. According to Lloyd 'now one finds oneself bending forward with the palm of the intra-uterine hand facing upwards. The object is to correct the torsion by grasping any available part of the foetus and assuming one's normal upright position. Several attempts entailing considerable physical exertion at arm's length are usually necessary to bring the calf into its correct position'. The advantages of the technique according to Lloyd were (i) little discomfort was caused to the cow, (ii) there was no risk of increasing the torsion, (iii) no equipment was needed, (iv) no lay assistance was required, (v) the technique could be completed quickly, normally within the space of fifteen minutes. Sloss and Dufty (1980) described the grasp on the inverted foetal head as 'Kamer's hold'. The technique of manual detorsion requires that the cow should be standing and both New (1929) and Seeman (1967) suggested that should the cow be recumbent, her rear end should be elevated before any detorsion was attempted. Scott (1958) found the method successful but suggested oscillating the calf in increasingly vigorous movements before finally turning it over.

Maguire (1934) advised correction of mild cases of torsion by applying traction to the calf, gently rotating it about its long axis at the same time. He noted 'the twist seems to naturally unfold itself and the surrounding parts expand naturally for the exit of the calf'. Jordi (1915) working in Switzerland advocated a similar method in which traction and rotation were applied to the head only, the foetal limbs being repelled into the uterus. Noting that he had successfully dealt with 'dozens of cases' the author followed detorsion by retrieval of the foetal limbs and delivery by traction. Other protagonists of this method included Crichton (1902) and Buckingham (1927).

McGillivray (1888) suggested a more severe method of rotation which he called 'jamming'. Calving ropes were attached to the foetus, severe traction applied and the foetus was jammed against the uterine wall at the pelvic inlet. The operator attempted to turn the foetus internally whilst those exerting traction tried to twist and rotate the limbs over each other thus correcting the calf's position and with it that of the uterus. A similar method was described by Williams (1929).

Auld (1947) found internal detorsion was aided by two helpers pushing either up or down on the opposite flanks of the cow - 'external manipulation' - to aid rotation of the twisted uterus. Epidural anaesthesia was recommended by Wilkinson (1947) to aid the manipulation.

Mechanical aid to rotate the foetus using a torsion fork was recommended by Demott and Roberts (1945) but Arthur et al. (1982) warned that although such instruments might be of assistance, care should be exercised to prevent uterine rupture. Gould (1972) described his use of an embryotome and wire in the rôle of a torsion fork to grasp the foetal limbs as an aid to rotation and detorsion.

Goron (1858) claimed to be the first person to use the technique of rolling the cow to correct uterine torsion, but according to Fleming (1877) the technique had been known on the Continent since at least the year 1845. One of the most popular methods of treating uterine torsion, rolling, is probably the best method of dealing with torsion when the cervix is closed or the torsion is too severe to allow manual access to the foetus. Foulkes (1905), Dowling (1927),

Williams (1929) and Wright (1939) were among protagonists of the method. Rolling may succeed where other methods have failed. Mahon (1890) described a case of torsion in a Norfolk polled cow. Rotation, rocking per vaginam and attempted traction had all been tried without success. The cow was finally rolled and the torsion was successfully dealt with. Help is required for rolling a cow and some sedation may be necessary. Seaman (1863) recorded the use of chloroform whilst Sloss and Duffy (1980) suggested sedation with chloral hydrate. Epidural anaesthesia was recommended by Richter (1929) and Dauvois (1932b). Deep bedding was necessary to avoid damage to the cow and Fleming (1877) advised that the patient's udder be emptied before rolling. This however might not be advisable owing to the increasing risk of hypocalcaemia.

The cow is cast on the side of the direction of the torsion. The fore legs are tied together as are the hind legs. The legs are pulled rapidly over the cow's back in the direction of the torsion. Vaginal examination throughout the procedure will help to stabilise the uterus and also to assess the success or otherwise of the rolling. Where rolling is contemplated it should be carried out without delay. Hoile (1872) described a case of torsion in which he delayed hoping for self resolution. He finally rolled the cow and delivered a dead calf.

The term 'rolling' may suggest rolling the animal down a hill or over and over repeatedly - a technique used unsuccessfully by Munro (1894a) and Shawcross (1912). A more carefully controlled method is normally employed. Penhale (1906) advised that the cow should be held on her back momentarily before rolling in an attempt to stabilise the uterus. The importance of rapid rolling was stressed by Pauer (1918). Haase (1904) advised that raising the rear end of the cow might aid the rolling process. Standley (1943) noted that often three revolutions were necessary to correct the torsion but Sloss and Duffy advised that, should more than three attempts at rolling be required, the technique should be abandoned in favour of another one.

The direction of rolling has been the cause of much debate and confusion. Cunningham (1897, 1899, 1901) thought the direction of rotation was unimportant but most authors agree that it should be in

the direction of the torsion. In the author's opinion it may be described as rolling the cow's body around her uterus which is held in position by its own inertia. Pack (1921) described a case in which he had attempted rolling a cow in both directions and had failed to correct the uterine torsion. The cow was slaughtered and at post mortem peritonitis and extensive adhesions were found to be holding the uterus in a fixed position.

Arthur (1966) described a method of detorsion by rolling the cow in conjunction with external abdominal pressure which had been originally described by Schäfer (1946). The method was later tried and endorsed by Roberts and Hillman (1973). Sloss and Dufty (1980) cited Frerking et al. (1975) as recording a success rate of over 90 per cent with this method. Four to six men were required and the cow was cast and tied on the side to which the torsion was directed. A wooden board was rested on the cow's abdomen and an assistant squatted upon it applying weight to the abdomen and restricting movement of the uterus while the cow was slowly rotated.

After successful rolling or detorsion by other means the foetus may be delivered unaided or require further assistance. Collett (1922) having corrected a case of torsion found the calf malpresented and requiring embryotomy to allow delivery. In another case Campbell (1923), having successfully rolled a cow left her to calve unaided but she failed to do so and the foetus died before it could be delivered. De Bruin (1904) advised that the uterus should be allowed to regain ample blood supply after correction of the torsion and before foetal delivery if uterine ischaemia and rupture were to be avoided. Götze (1929b) advised that if epidural anaesthesia had been used in detorsion procedures, its effects should be allowed to wear off before delivery was attempted.

Cartwright (1861a) described two cases of cattle which had been rolled after a delay of three days. Both cows unfortunately died of exhaustion and haemorrhage after rolling. Failure of the cervix to dilate after correction of torsion was described by Fraser (1929) who warned of the dangers of uterine rupture in such cases especially where the foetus was in posterior presentation. If the cervix had not dilated fully following detorsion or if the foetus was dead, Pearson (1973) advised that caesarean section should be immediately

carried out. The successful use of oxytocin in cases of non-dilation of the cervix following rolling has been discussed (Anon., 1913a) but in the author's opinion such treatment would be inadvisable considering the fragile and ischaemic nature of the uterus.

Surgical treatment may be considered when the previous methods have failed to correct uterine torsion. Tischlauser (1939) however regarded it as the method of choice. Under local anaesthetic he made a small incision through the flank wall, corrected the torsion and then sutured only the skin afterwards. The calf was delivered twenty-four hours later if birth had not occurred spontaneously in the meantime. Staggs (1925) having attempted without success to roll a case of uterine torsion corrected it through a laparotomy wound. The foetus was delivered per vaginam. Staggs resolved 'never again to spend much time rolling cows'. The surgical method was in his view better for the veterinary surgeon, patient and client.

Carlisle (1840) was one of the first British authors to describe surgical treatment of uterine torsion. He made no attempt to roll the cow which was the subject of his article but performed a mid-line laparotomy to remove the foetus. No details of calf survival were given but the cow, perhaps not surprisingly, died shortly after the completion of surgery. Some years later Cartwright (1850a) discussed the merits of surgical interference and advised that laparotomy be performed, the uterus replaced and the animal sewn up again and allowed to calve unaided. Whilst this course of action may work well (Anon., 1913c) each case should be judged on its merits (Anon., 1951). Where delivery per vaginam is impossible or doubtful then it may be wise to proceed to caesarean section immediately before closing the flank wound. Although Gendreau (1944) and Arnold and Usenik (1957) recommended correction of torsion before caesarean section this may not always be possible. Arthur et al. (1951) described a case in which they were unable to correct the torsion and had to open the uterus in its twisted state. Repairing the surgical wound in the uterus in such circumstances may be extremely difficult.

CHAPTER NINE

DYSTOCIA CAUSED BY MULTIPLE BIRTH

The cow is essentially a monotocus animal and the occurrence of twins is relatively uncommon. Sloss and Dufty (1980) suggested that the incidence of twins was in the region of two to three per cent of all births. Arthur et al. (1982) considered twins twice as common at 1.04 per cent among dairy cattle than among beef cattle at 0.5 per cent. These authors also noted a breed difference, recording an incidence of one per cent of twinning among Jersey cattle, three per cent among Holsteins and eight per cent in the Brown Swiss breed. Arthur et al. (1982) also considered that the incidence of twinning might increase with age and that a cow which had produced twins at an earlier gestation was more likely to do so again than a cow which had produced a singleton.

Triplets, quadruplets, quintets, sextuplets and septuplets in cattle have all been recorded in the literature. Sloss and Dufty (1980), reviewing the world literature, estimated the incidence of triplets to be 0.002 - 0.007 per cent whilst Arthur et al. (1982) estimated that 0.013 per cent births might result in triplets. The presence of multiple fetuses in the uterus may be unsuspected and Parker (1916) recorded a case in which a cow had delivered two calves and when examined still straining twenty-four hours later a third calf was found in the uterus. Davies (1944) reported a case in which triplets weighing a total of 160 lbs were removed manually from a first calf heifer.

There are a number of references to the birth of bovine quadruplets in the literature and their incidence at parturition has been estimated (Anon., 1956) as being one in 14 million calvings in beef cattle. Roberts (1971), however, suggested a higher incidence of one in 700,000. One of the earliest reports of bovine quadruplets was that of Maddocks (1840) who in a paper entitled 'An extraordinary case of Superfoetation in a Cow' described the delivery of four calves by a first calf heifer. Olver (1932) who was called to a cow suffering from suspected tympany found her dead on arrival with, on post mortem, a ruptured uterus with three calves in utero and the fourth free in the abdomen. A successful case in which four calves were delivered after

eight months gestation was described by Bell (1959). The calves, which weighed a total of 152 lbs were reported to be alive one year after their birth. A somewhat unusual case of quadruplets was described by Bennett (1960) who was called to a cow which had been attempting to calve for five hours. Two calves were impacted at the pelvic inlet and following their removal two more were found in the uterus and removed. Shortly after their birth the cow was observed to be extremely hyperexcitable and to begin violently licking herself and her box. Nervous ketosis was diagnosed and the cow responded well to treatment. The fate of her calves was not recorded. Another case of quadruplets was described by McDonald (1932) in a sixteen-year-old Ayrshire cow. The farmer suspected twins and McDonald delivered four living bull calves which lived for one week but then died suddenly of unknown cause. The cow suffered a retained placenta but recovered well and was reported to be in calf again two years later.

Multiple birth in cattle is not necessarily associated with dystocia and Garrard (1854) recalled seeing quintuplets delivered unaided by an eleven-year-old cow. He reported that the cow and her family were well and that her owner was charging six pence to all comers wishing to see this unique family. Quintuplets born at an assisted delivery were reported by Fleming (1872). The total weight of the slightly premature calves was nearly 200 lbs but unfortunately they died of 'scours and starvation' after a few days. The first calf in this case was delivered by traction and the others followed unaided after 'a long and laborious labour'. Four of quintuplet calves survived in a case described by Jarvis (1899).

Gross abdominal distension may accompany the presence of five calves in the uterus and Slettum (1928) reported a case which he suspected of being twins in which the cow was eating well although she was extremely weak. Called in to assist, Slettum found great difficulty in finding his way about the grossly distended uterus. He reported violent labour pains preceding his arrival. Three calves were delivered and the fourth was almost beyond his reach but nonetheless he managed to deliver it by traction. A fifth calf was expelled by the cow herself twenty-four hours later. Three of the calves were stillborn and two were alive at birth but did not survive.

Siemer (1931) suggested that the incidence of quintuplets might be one in 41 million bovine pregnancies and described a case which he had encountered in practice involving a first calf heifer. The heifer had been depressed and uncomfortable for four weeks prior to the birth of

her offspring. Vaginal examination revealed the first calf in bilateral shoulder flexion at the pelvic inlet. Following correction of the defect and delivery of this foetus, four more calves were delivered with a total weight of nearly 200 lbs. Five dead calves were delivered from a Welsh cow by Miles (1935) and Donald (1951) described a case in which five living calves were delivered unaided by a second-calf cow. Reviewing the literature, Donald noted that quintuplets had been reported on at least eleven previous occasions. Low (1933) reported a case in which he delivered two premature calves without difficulty. Two more calves were delivered the next day but unfortunately the cow died and a further two calves, making a total of six, were found post mortem. The author wondered whether his case was in fact a world record. It apparently was not since a brief description of the cow which delivered seven dead calves unaided was reported some years later (Anon., 1953).

The outcome of multiple birth, including twins, in cattle is frequently unsatisfactory. Surveys by Daerr and Grünert (1970) and by Kay (1978) have quantified some of the problems which may accompany twin birth. Daerr and Grünert (1970) found that the incidence of posterior presentation and malposture was higher in dystocias involving twin calves than in dystocias involving singleton calves. They also found that stillbirth was thrice and neonatal disease twice as high in twin calves. They concluded that twin birth was attended by much greater stress for both cow and calf. Kay (1978) found calf mortality was four times higher among twin calves than among singletons whilst retention of the placenta was also four times more common following the birth of twins.

In a follow up study Kay found that 25 per cent of cows which delivered twins and suffered retention of the placenta failed to breed again. On the positive side he found that cows which produced twins had a higher than average milk yield during the subsequent lactation. The tendency to retain the placenta following twin births was also noted by Curtis (1973) who suggested the routine administration of 40 i.u. of oxytocin after birth to reduce the incidence of this problem. In a cautionary account, Eve (1920) described a case in which the cowman had delivered twin calves with some difficulty and then had attempted to detach the placenta by twisting it between two thatching

pegs. The cow was later found to be suffering from a ruptured uterus caused either by the attempts to correct the dystocia or to remove the placenta by tearing. Quite remarkably the cow, despite her injury, recovered well.

The presence of twin foetuses may cause serious problems to the obstetrician. Fleming (1877) noted the difficulty of identifying the presence of two or more foetuses especially in the neglected cases where foetal impaction at the pelvic inlet might occur. He also observed that the size of the bovine birth canal precluded the simultaneous passage of two calves although each individual member of the twin pair should pass with ease since their size tended to be less than that of the single calf. Fleming also noted that uterine inertia might complicate twin birth as might malpresentation, especially of the second foetus.

Sloss and Dufty (1980) considered that dystocia in twin birth might occur in one of three ways: (a) ineffective labour due to weak myometrial contraction, (b) simultaneous presentation of both foetuses and (c) malposture of one of the foetuses. These authors noted that ineffectual labour occurred most frequently among housed cattle which had little exercise and might develop before the birth of either foetus or after the successful delivery of the first. They considered the bovine uterus unsuitable for the delivery of twin foetuses. Whereas in other species selective myometrial activity presented successive foetuses at the pelvic inlet for delivery, the cow had non-selective myometrial activity. In this species uterine contraction commenced at the ovarian pole of the uterus and moved without interruption along the uterine wall towards the cervix. In bicornual pregnancy, simultaneous presentation would almost certainly result from such contraction whilst in unicornual pregnancy the anterior foetus was pushed into the posterior foetus causing malpresentation of the latter or both at the pelvic inlet. Despite these warnings twin birth does on occasion occur without dystocia.

The problem of simultaneous presentation of both foetuses may involve various combinations of longitudinal presentation of the two calves. Sloss and Dufty (1980) found that twin calves, either both in anterior presentation or one in anterior and one in posterior presentation, occurred in approximately equal numbers whilst the

presentation of both foetuses in posterior orientation was much less frequent. An earlier study by Bedel (1906) involving nineteen pairs of twins found that in thirteen cases the calves were one in anterior and one in posterior presentation. In three cases both calves were in anterior presentation and in the other three both were in posterior presentation. Treatment of simultaneous presentation requires careful assessment and examination to decide which legs, head, and body belong to the same calf. Canu (1838) recommended tying coloured threads to the limbs of the calves in utero in an attempt to aid external identification of each member of the pair and his recommendation was later supported by Cartwright (1846a).

In some cases of simultaneous presentation one calf may be found to be slightly in advance of the other at the pelvic inlet and in such cases this calf may be delivered by traction following repulsion of the second member of the pair. Should both be equally advanced in the birth canal, one calf must be repelled and the other delivered by traction. In cases where the calves are presented in anterior and posterior presentation respectively, the author of this thesis has found that it is more simple to deliver the calf in posterior presentation first. The posteriorly presented calf has only two appendages to bring through the birth canal whilst the anteriorly presented calf has three. Sloss and Dufty (1980) have suggested the use of oxytocin after the delivery of the first calf to aid uterine contraction with presentation of the second calf at the pelvic inlet.

Malpresentation of one foetus is quite frequently encountered in twin calf dystocia and may involve either the first or the second foetus. Breech presentation is one of the most frequent malpostures seen and cases have been reported by Cartwright (1846b) and MacDowell (1922). Great difficulty can be experienced if the breech malposture has become impacted in the pelvic inlet. Davis (1924a) recorded a case in which he was unable to repel or correct the malpresentation and the foetus was delivered in an uncorrected state using an anal hook pulled by four men. Brooksbank (1932) described a case in which an emphysematous calf in breech presentation was found dead at the pelvic inlet and delivered following embryotomy. A second calf, also in breech presentation, was found behind it and following correction of the malposture was delivered by traction. Twin calvings may be

easily complicated or damaged by lay interference. Laycock (1857) described attending a weakened cow in which 'persons who had attempted to calve her had entangled the legs of what appeared to be two calves'. He delivered the first calf by embryotomy and traction and decided that the cow was too weak to attempt delivery of the second calf. He later learned that a farrier had done so by severe traction after which the unfortunate cow had died. Traction may be inadvertently applied to two calves at once. Parker (1915b) recalled a case in which six men had attempted to deliver a calf by applying traction to its feet and legs. When called, he found that traction had in fact been applied to the head of one calf which was presented with bilateral shoulder flexion and to the forefeet of another which had lateral deviation of the head. He delivered the calves by embryotomy and the cow made a good recovery. A somewhat unusual case of twin calf dystocia was described by Miller (1863) who reported the case of a cow which had delivered her first calf unaided. Twenty-four hours later straining recommenced and he discovered a calf in transverse presentation and dorsal position which he delivered having severed the vertebral canal using a small knife. The cow in this case also made a good recovery.

Uterine rupture with the passage of one calf into the abdomen was reported by Hudson (1919) and Low (1924). In both cases the cow had delivered one small calf and a second calf was expected but none was found in the uterus. Both cows died and at post mortem a second calf was found free in the abdomen in each case.

The importance in all cases of carefully searching the uterus for a second calf after delivery of the first cannot be over emphasised. Although the incidence of twins is relatively low, the frequency with which dystocia occurs in twin births increases the likelihood of veterinary surgeons encountering such cases. In some cases delay in delivering a second calf may cause no ill effect. Blake (1846) described a case in which he was called to a cow which had calved three days previously. A second living calf in normal presentation was found and was later delivered unaided. A somewhat similar but complicated case was described by Findlay (1897) who was called to a cow which had produced a calf without difficulty two days previously. He discovered an oedematous and malpresented second foetus which he delivered by prolonged embryotomy. The cow suffered some fever but

recovered well. Cervical closure may occur following the birth of the first calf and before the second calf has been presented at the pelvic inlet (Lewis, 1879).

A number of cases have been recorded in which authors have suspected superfoetation in that the calves have been born to the same cow up to four months apart - apparently in the same period of gestation (Peele, 1931; Barr, 1961; Holmes, 1961; Bell, 1972, Cox, 1972). Superfoetation was suspected but not proved beyond doubt in each case and it is possible that the cows had poached calves from other cows either before or after their own calving dates.

Despite the many difficulties associated with twin calving Hammond (1959) proposed that beef cattle should be aided in producing twins, using PMSG, in an attempt to increase British beef production. He did not advocate induced twinning in dairy cattle which were intended for breeding because of the risk of freemartinism in female calves. He warned that there would be an increase in incidence of retained placenta and careful and adequate calf feeding would have to be practised if the prospective small size of twin calves was to be overcome. A trial involving two thousand Welsh cattle was proposed.

Much concern was expressed at the difficulties which might accompany such a trial. Bateman (1958) described twins as 'a menace', while Grant (1959), Tutt (1959) and Williams (1959) all warned of the potential dangers of twin calves. Grant (1959) reported poor calf survival and a high incidence of dystocia in a small herd with which he was associated. High foetal mortality and a very high incidence of retained placenta were reported by Williams (1959). Crew (1960) warned of the dangers of causing the essentially monotocous cow to become polytocous and advised caution in widespread use of induced twinning. Although Gordon and Williams (1961) reported reasonable results from a part of the trial the consensus view was, and is, that twinning in cattle has little to recommend it and that where it is suspected, careful obstetrical supervision is necessary.

Recently increased fecundity in sheep has been achieved by treatment of ewes prior to mating with antisera to gonadal steroids (Land et al., 1982) in an attempt to modify hormonal feedback to the anterior pituitary. It has been suggested (Land, personal communication) that the method might be applied to cattle. The problems

associated with twinning, already discussed, would have to be carefully considered should commercial application be contemplated.

CHAPTER TEN

DYSTOCIA CAUSED BY FOETAL OVERSIZE

The incidence of foetal oversize as a cause of bovine dystocia has increased in recent years. This increase has coincided with the rising popularity of the Friesian Breed and the importation of so called 'exotic breeds' of cattle into Britain (Arthur et al., 1982). The need for the foetus to pass through the confines of the bony pelvis during birth, necessitates pelvic size to be considered in any discussion of foetal oversize. In their discussion of the problem, both Sloss and Dufty (1980), and Arthur et al. (1982) have considered foetal and pelvic size together using the terms "Foeto-pelvic disproportion or Foeto-maternal disproportion". Benesch (1938) attempted to differentiate between absolute and relative foetal oversize. Absolute oversize was caused by over-development of the foetus when the maternal pelvis was of normal size, whilst relative oversize occurred when the maternal pelvis was abnormally small and the foetus was within the normal range for the breed. The clinical problem presented to the obstetrician is very similar although a small maternal pelvis may make access to the foetus particularly difficult.

Although the incidence of foetal oversize has increased, the problem has long been recognised. Farrow (1865) noted that dystocia might be caused by 'morbid enlargement of the foetus' caused by either dropsy or decomposition. Similar problems were noted by Fleming (1877) who described foetal anasarca and foetal emphysema, the latter occurring when 'the foetus has perished in the uterus'. Arthur et al. (1982) recognised three forms of foetal oversize:-

- a) Absolute foetal oversize,
- b) Relative foetal oversize,
- c) Pathological foetal oversize.

The latter category might include enlargement of the foetus caused by dropsy, emphysema or monstrosity. Dystocia resulting from both small bony pelvis and foetal monstrosity has been discussed elsewhere in this thesis and this chapter will consider the problems of absolute

foetal oversize and of the emphysematous foetus only. The many factors involved in determining the size of the foetus at birth were discussed in Chapter Four and have been summarised by Sloss and Dufty (1980). These authors noted that foetal size, weight and conformation depended on the size, age and parity of the dam, its nutritional state during pregnancy and the sex, gestation length and breed of the foetus. Other specific factors involved in the development of the foetal oversize have appeared from time to time in the literature.

In a question and the answer series for practitioners (Anon, 1949) it was suggested that swedes fed to first-calf heifers during pregnancy might result in oversized fetuses. The relationship was noted but the problem was believed to be exacerbated by the poor muscle tone of dams fed in such manner.

Great interest was shown in the weight of large calves born after dystocia following gestation of normal length (Johns, 1926; Burgon, 1930; Bell, 1936; Eaton, 1946; Hall, 1946 and Swift, 1946). Calves of between 125 and 170 lbs were described and in many cases the authors wondered if their calves were of record birthweight. One of the largest birthweights recorded, 172 lbs, was that of a calf delivered by traction from a Friesian heifer (Tuckey, 1956).

The intentional production of oversized calves in beef producing areas has been discussed by Ménissier (1980) and milk production following the birth of larger calves quantified by Erb et al. (1980) and Chew et al. (1981). The latter authors warned that although a greater milk yield might follow the birth of a large calf, the subsequent problems following possible dystocia might negate the expected advantage of yield.

Prolonged gestation may play an important part in the development of foetal oversize. Williams (1943) who considered that calves of excessive volume were authentically recorded in but rare incidences, believed that most cases were 'the consequence of prolonged gestation'. Cox (1875 and 1876) reported that he encountered 'many cases' of dystocia associated with prolonged gestation lasting three to twenty-three days beyond the normal calving date. It has been shown that certain breeds of cattle characteristically have a gestation period longer than others and this tendency may be passed on in cross breed-

ing. O'Mary and Hillers (1976) observed that Aberdeen Angus heifers served by Charolais bulls carried their calves on average 4.5 days longer than those served by Aberdeen Angus bulls. The rate of foetal growth increased up to day 202 of gestation according to Prior and Laster (1979), after which the rate fell off slowly. Although no relationship between foetal weight and placental area was demonstrated by Wild (1964), Burris and Blunn (1952) believed that the potential capacity for excessive foetal growth in the bovine uterus was considerable.

Callaghan et al. (1969) considered that there were two main types of prolonged gestation in cattle caused by: a) aplasia of the pituitary gland and the brain which was seen chiefly in Channel Island breeds and b) post-term growth which they believed was associated with a basic defect of carbohydrate metabolism. A number of accounts of foetal oversize caused by absence of either brain or pituitary gland have been recorded (Pouchy, 1841; Wilson, 1868; Huston and Gier, 1958; Irvin, 1966 and Callaghan et al., 1967). Gestation lengths of 329 to 589 days were recorded and in each case the calf weighing up to 138 lbs was delivered by prolonged traction. Occasionally other foetal monsters without signs of pituitary abnormality have been associated with prolonged gestation. Drabble (1895) recorded the attempted delivery of a schistomus reflexus monster following gestation of 643 days, whilst Johnson and Haxby (1955) delivered an anasarctous foetus weighing a remarkable 214 lbs by caesarean section following a gestation length of 351 days.

A number of specific examples of post-term growth have been noted in the literature (Wheatley, 1840; Eaton, 1919; Hey, 1936; Edwards, 1946; Williams, 1954; Jones, 1964 and Whiteford, 1969). Gestation was mostly in the range of 300-370 days and calf weight was up to 160 lbs. Dystocia was treated by traction, caesarean section or by embryotomy.

Occasionally 'outbreaks' of prolonged gestation have been seen and McGavin (1888) reported the case of a purebred Hereford cow, four to five weeks overdue suffering dystocia. Traction by ten men failed to deliver the large calf and embryotomy was required to effect delivery. Four other similar cases had also been seen on the farm. A similar problem was described by Robinson (1896) who, in his North

Wales practice, had encountered eight cases of prolonged gestation in one year. Gestation lasted eleven to thirteen months and the foetal oversize was complicated by uterine inertia and lay interference. Following disastrous results with the first two cases the remainder were sent for emergency slaughter once foetal oversize was diagnosed. Jasper (1950) recorded a problem of prolonged gestation in a 250-cow herd. Thirty cases were seen and were believed to be associated with a single recessive characteristic. Numerous dystocia cases occurred and required either forced traction or embryotomy. The fetuses showed signs of post-term growth including long hair but no signs of pituitary abnormality. Wilson and Young (1958) reported nine cases of prolonged gestation in an Ayrshire herd. The calves were all the progeny of one bull, most were heavier than the breed average and required assistance at birth. A complex genetic cause was suspected.

It was noted in Chapter Four that the problem of double-muscling contributed greatly to the occurrence of foeto-pelvic disproportion. One of the earliest reports of this condition was that of Hewetson (1933). Called to a parturient Galloway cow, he used manipulation and traction under chloroform sedation to deliver the calf which had 'double-layered buttocks and shoulders out of proportion'. A high incidence of double-muscled calves in South Devon cattle was recorded by MacKellar (1960) who noted that in some herds 50 per cent of the calves born were of the double-muscled type. Caesarean section was frequently required but some animals calved without aid especially if allowed plenty of time. Vandebussche et al. (1964) found double-muscling the most important cause of dystocia in Belgian cattle and noted that 78 per cent of affected calves were born dead or died within the first ten days of life.

During a recent visit to Belgium (Jackson, unpublished data) the author was able to see a number of Belgian Blue-White herds in which double-muscling was prevalent. Up to 80 per cent of parturient cattle required caesarean section and many cows had an annual operation to deliver their calves. During the calving season local veterinarians might perform six caesarean sections a day and even in small herds parturient cows were watched and monitored using closed-circuit television. The large double-muscled foetal tongue was used to diagnose the presence of a double-muscled calf in the uterus and considered to

indicate the need for an immediate caesarean section without traction being attempted. Belgian farmers actively encouraged the production of double-muscled calves and many bulls of this variety are in use both at Artificial Insemination Centres and on private farms.

Hanset and Jandrain (1979) observed that although double-muscled calves might only weigh 8 kg more than their normal counterparts, their value might be three times as great. The cost of caesarean section was approximately one-tenth of the calf's value and thus there was no incentive to eliminate the problem. Indeed active selection for the double-muscle characteristic had resulted in a steadily increasing need for caesarean section each year. Hanset and Jandrain concluded 'what is considered amazing outside Belgium, has become common practice'. Illustrated below (Plate 16) is a double-muscled Belgian Blue-White stock bull.

PLATE 16



Double-muscled Belgian Blue-White bull - photographed on a small stock farm near Waterloo, Belgium.

The oversized emphysematous calf presents a grave challenge to the veterinary surgeon. The condition may be associated with neglected dystocia cases in which infection has gained access to the uterus and foetus. Describing a case which he had seen after a 'cowleech' had attended, Drouard (1842) noted 'the engorgement of the vulva and the dreadful excoriation and wounds that appeared, too plainly showed the violent and ill-directed means that had been adopted'. Fleming (1877) also graphically described cases of foetal emphysema thus, 'on approaching an animal in which the foetus is emphysematous a powerful stench is received coming from the vulva, the lining membrane of which is of a yellowish-red tint. On introducing a hand into the uterus, the inflated foetus crepitates on pressure and the gases can be moved beneath the skin. The hair is coarse and easily removed, the skin itself is dry and fluids are small in quantity. Gases are not infrequently disengaged from the foetal membranes'.

Sloss and Dufty (1980) suggested that following foetal death the onset and rate of putrefaction depended on the degree of patency of the genital tract. Contamination of the foetal parts with faeces greatly increased the speed of decomposition. According to these authors emphysema commenced at those parts of the foetus closest to the vulva and spread to the rest of the foetal body. The presence of the dead and emphysematous foetus within the uterus may in some cases cause severe illness of the dam whilst in other cases little outward sign of the problem may exist. Great difficulty may be experienced in attempting to examine the foetus as a result of the dryness and distension which accompany foetal emphysema despite repeated applications of lubricant. According to Sloss and Dufty (1980), the prognosis of cases of foetal emphysema depended on the degree of toxæmia and metritis and also on the severity of vaginal necrosis. These authors also considered that the maternal death rate might be as high as twenty per cent. Cartwright (1846c) recalled a calving case in which he had to perform embryotomy to remove an emphysematous foetus. Unsalted hog's lard was recommended as a lubricant in such cases by Cox (1877a and b) whilst Findlay (1897) described his application of embryotomy to remove an unexpected twin emphysematous foetus presented two days after the birth of its co-twin.

Delivery of the emphysematous foetus may present considerable difficulties. Traction applied following generous lubrication may be successful and Williams (1943) advised that numerous incisions should be made in the foetal skin to allow as much gas as possible to escape, thus reducing the overall size of the foetus. This author also suggested that severe traction could safely be applied since the cushioning effect of the trapped air within the foetal body would protect any particular part of the birth canal of the mother from damage. Sloss and Dufty (1980) on the other hand warned against severe traction and suggested that if the foetus was accessible per vaginam, embryotomy was the method to choose. They suggested that if the foetus was beyond reach, midline caesarean section should be employed. Pre-medication with spasmolytic and antibiotic therapy prior to caesarean section was also recommended. The author of this thesis has found that in most cases traction is effective provided adequate lubrication and re-lubrication can be applied.

Clinical Signs of Foetal Oversize

The clinical signs of foetal oversize may not always be clear although in some cases the problem is anticipated as a result of misalliance or the use of exotic sires on indigenous cattle. Sloss and Dufty (1980) noted that initially strong but unproductive straining might be observed, resulting in expulsion of foetal fluids and intense uterine contraction without movement of the foetus. As a result, the vagina might be dry and great difficulty might be experienced in inserting the hand into the birth canal in an attempt to compare the size of the foetus and the dimensions of the maternal birth canal. Arthur et al. (1982) remarked that often the veterinary surgeon was called in after second stage labour was well established. Initially the problem might appear to be in the foetal head passing the vulval lips. In reality the cause of the problem was that the foetal chest and shoulders were impinging upon the pelvic inlet. These authors also found that considerable difficulty might be experienced in attempting to assess foetal size by palpation.

Delivery of the oversized foetus

A number of different methods are available to the veterinarian when considering the most satisfactory way in which an oversized foetus may be delivered. Arthur et al. (1982) proposed that they might be listed as follows:

1. Delivery by lubrication and traction,
2. Increasing the diameter of the pelvic outlet by episiotomy,
3. Caesarean section,
4. Embryotomy.

Whenever possible the above authors believed that the method selected should conform to 'the obstetrician's ideal' - to render abnormal birth as near to the physiological as possible and to preserve the life of both mother and foetus.

One of the greatest difficulties to be encountered by the veterinary obstetrician is to decide when a large foetus may be delivered per vaginam and when operative delivery is required. The incorrect decision can have grave consequences for both dam and foetus. Arthur et al. (1982) considered that the experienced veterinarian might be able to decide at once whether vaginal delivery was possible and advised that this, the simplest method, should be tried first. All plans should be tentative rather than rigid and when a simple method failed, the more complicated procedures of caesarean section and embryotomy should be employed. During delivery by traction episiotomy might be carried out to avoid uncontrolled rupture of the perineum.

Most experienced veterinarians would admit that they have made incorrect decisions concerning the mode of treatment to be employed in a particular case of foetal oversize. In order to avoid the problem, attempts have been made to find formulae based upon measurements which would guide the veterinarian in his decision-making. Hindson (1978) attempted to 'provide and establish a workable ratio of maternal pelvic inlet and foetal size'. He hoped to avoid the 'traction - failure - surgery' sequence and to proceed immediately to surgery when this was clearly indicated. He considered the most useful ratio was that between the inter-ischial tuberosity diameter

of the dam and the digital diameter, being the width of the foetal limb at the fetlock joint, of the foetus. Hindson's formula was as follows:

$$\text{Maternal/foetal ratio} = \frac{II}{DD} \times \frac{P1}{P2} \times \frac{1}{E}$$

Where II = inter-ischial diameter

DD = digital diameter of the foetus

P1 = parity factor of 0.95 (used in the case of first calf heifers)

P2 = correction factor of 1.05 (used in cases of posterior presentation)

E = 'exotic' factor of 1.1 (used for breeds in which muscular hypertrophy in calves was known to occur).

When the ratio calculated was 2.5, Hindson considered that foetal oversize was not present and that vaginal delivery was likely to be possible. When the ratio was in the range 2.3-2.5, strong traction was likely to be required to deliver the foetus and when the ratio was below 2.1, vaginal delivery was considered impossible. Hindson later (personal communication) attempted to measure the foetal digital diameter before birth using an electronic device per rectum.

Unfortunately not all workers agreed that Hindson's formula worked satisfactorily. Clarke-Williams et al. (1979) who tested it on 46 Friesian cattle found that nine animals required considerable assistance despite the fact that their ratios were above 2.75 which should have meant that delivery would be achieved without difficulty. Although the digital diameter of the foetus can be measured with considerable accuracy, the points at which the inter-ischial diameter is measured are less precise and may account for some of the discrepancies encountered in the use of the formula.

Armstrong et al. (1978) proposed a programme of 'trial traction' for potentially oversized calves in both anterior and posterior presentation. For anteriorly-presented calves ropes were applied in the normal way to the head and feet of the calf. The feet were pulled well out of the vulva and held in this position. When traction was applied to the legs, it was noted that the head usually remained further back in the uterus. One man would then apply traction to the head rope and had to be able to pull the calf's head

into the pelvic cavity with comparative ease. If he could achieve this manoeuvre, delivery per vaginam could normally be accomplished. If he could not, caesarean section was usually indicated. If he could only bring the head into the pelvis with considerable difficulty, the use of a calving aid was recommended. For the posteriorly-presented calf, one hind leg was pulled into the pelvis by two men and held in this position. The other hind limb had to be able to be pulled into the pelvis by one man to an equal distance as the first if traction was likely to succeed.

A somewhat similar method of test traction was proposed by Schuijt and Ball (1980). For the foetus in anterior presentation they proposed the following procedure:- The cow was cast on her right side, chains were attached above the calf's pasterns but no rope was to be applied to the head. Unilateral traction was applied to the lower limb by one person until the foetal shoulder was felt to pass the medial aspect of the maternal ilium. Should it not be possible to palpate the foetal shoulder, its passage past the ilium might be assumed if 10 cm of the foetal limb (15 cm for calves of large breeds) had passed through the vulva. Unilateral traction was then applied to the upper limb by one man. Vaginal delivery would be possible if the second foetal shoulder passed the medial aspect of the maternal ilium on that side. The authors noted that their method of test traction might be more acceptable if it could be applied to the standing cow and hence avoid the necessity of casting the animal to apply the test. They believed, however, that the weight of the calf in the standing cow might give a false indication of difficulty in bringing the foetal legs into the maternal pelvis.

In the case of the posteriorly presented calf the authors suggested that the foetus should in every case be rotated through 90° so that its widest part (the distance between the femoral trochanters) should be presented at the greatest diameter of the maternal pelvis (the dorso-ventral diameter). Schuijt and Ball suggested that safe vaginal delivery would be possible if two people pulling simultaneously on the rotated calf could withdraw it sufficiently for its hocks to be clearly visible at the vulva. They stressed the importance of avoiding traction in any cases of posterior presentation in which there was any doubt about safe vaginal delivery since the calf was particularly likely to suffer anoxia.

The author of this thesis has unfortunately no personal experience of using either the method of Armstrong et al. (1978) or that of Schuijt and Ball (1980), but considers them to be worthy attempts to solve a difficult problem in the field.

During delivery of the oversized foetus, the problem of 'hiplock' may occur. The head and thorax of the anteriorly presented foetus pass through the birth canal following traction but then no further progress is made. According to Arthur et al. (1982) the problem occurred when the foetal pelvis became impacted in the maternal pelvic inlet. The exact point of obstructive contact can be difficult to ascertain since in most cases there is little room within the birth canal to allow satisfactory palpation and exploration. The term 'stuck at the hips' has also been used (Burgon, 1934) and the problem is especially severe in cases where prolonged straining and loss of foetal fluid has resulted in the foetus becoming wedged into the pelvic inlet. Ewing (1968) considered that the cause of obstruction was not interlocking of the maternal and foetal pelvices but was caused by the thickened muscle masses of the thigh of the calf which were broadest just caudal to the greater femoral trochanters. Farrell (1968) reported that he had also encountered the problem of calves with heavy muscular development of the thighs, especially those sired by Hereford, South Devon and Murray Grey bulls. Fleming (1877), however, believed that the point of impaction was between the foetal stifles and the anterior aspect of the pelvic brim of the dam. The author (Jackson, unpublished data) supports this view having palpated the impacted stifle joints in cases of foetal oversize in the field. The finding of epiphyseal fractures at the distal end of the femur of large calves following traction can also be considered as evidence of stifle impaction (Fraser, J.A., personal communication). In a detailed study of 'hip-lock' cases, Mickelsen (1976) found that the foetal hips were free within the maternal pelvis but the stifles were firmly impacted at the pelvic brim. Well-developed stifle joints contributed to the problem as did improperly directed traction.

Hartigan (1979) considered that premature interference especially in Charolais calvings might lead to an increased incidence of hip-lock. He considered that this breed needed five hours to complete the second

stage of labour and noted that the incidence of hip-lock fell if no interference was made before five hours of the second stage of labour had elapsed.

Various methods of correcting the problem of hip-lock have been described. Buckingham (1927) dealt with the problem by 'pulling the calf side-ways so one hip came through before the other', whilst Goldsmith (1930) repelled and rotated the foetus. A similar technique was used by Burgon (1934) but in his case twelve men had previously attempted traction without rotation resulting in the cow suffering a fractured pelvis.

Straiton (1957) advised that the cow be rolled on to her back and then on to the opposite side from that on which she had originally be lying. This simple manoeuvre, he reported, was successful in eighty per cent of cases. In cases in which it was not successful Straiton rotated the calf with the aid of a torsion bar. Michelat (1966) also found rotating the cow on to her back to be advantageous probably as a result of dislodging the impacted foetal parts from the pelvis and allowing a more satisfactory disposition to be adopted. Interesting advice was offered by Schuijt and Ball (1980), who believed that as soon as any sign of hip-lock was detected traction should immediately cease. The nostrils of the calf should be cleared of mucus and attempts made to stimulate breathing. Traction was, at this stage, contraindicated as it prevented the calf from breathing sufficiently to maintain life, the umbilical circulation having been obstructed by the calf's position. Schuijt and Ball believed that natural straining with tilting of the maternal pelvis would in most cases allow the calf to be delivered unaided. Unfortunately, in the author's experience, the combined effect of recent thoracic pressure and compression of the foetal abdomen by the cow's vulval lips make the establishment of natural respiration extremely difficult in such circumstances.

Somewhat similar advice had been given by Mickelsen (1976) who advised that if the cow was standing the calf might be left with its forequarters hanging down from the vulva for up to twenty minutes. During this time the calf was encouraged to breath and given oxygen and in most cases the cow 'relaxed' sufficiently to allow passage of the foetus. In difficult cases Mickelsen found that correction of

hip-lock might be aided by using a torsion fork inserted under the foetal pelvis to lift that portion of the calf to as dorsal a position as was possible in the maternal pelvis. This manoeuvre would take advantage of the widest lateral diameter of the maternal pelvis.

Embryotomy was employed by Gibbons (1934) to deal with an impacted case in which foetal repulsion and rotation were impossible. The technique of embryotomy was also recommended by Borsberry (1974) who reported that he could complete the operation within ten to twenty-five minutes. The technique is of course only appropriate when the foetus is dead or a decision is made to sacrifice its life.

Graham (1979) reviewed the traditional methods of dealing with hip-lock. These were:- 1) traction in a downward direction, 2) rotation of the calf to the right or left, 3) traction on one leg after slight repulsion of the calf, 4) traction on the head without the legs, 5) total embryotomy. Graham considered that his technique of collapsing the foetal pelvis was very satisfactory, but it could only be applied in the case of a dead foetus. A 30-inch blunt hook was inserted into the calf's abdomen just caudal to the xiphi-sternum. The hook was used to grasp the calf's pelvis wherever it could be engaged and sharp traction was applied to cause fracture of the bones. Ideally the foetal pelvis was fractured in two or three places allowing its total collapse and reduction in size. In the author's view this technique is not satisfactory and tremendous force would undoubtedly be required to cause fracture of the foetal pelvic bones. The task may, however, be less arduous if the foetus is somewhat decomposed and can be aided by prior evisceration of the foetus (Wilson, J.C., personal communication).

If the calf was presented posteriorly and hip-lock occurred Graham considered that traction applied to one leg might release the impaction. Failing this the pelvis could be fractured using the long blunt hooks. Many years earlier Cartwright (1846b) recommended symphysiotomy for similar impacted posterior presentations. The problem of hip-lock may be expected during the delivery by traction of most oversized foetuses but in the author's experience (Jackson, unpublished data) it can usually be corrected by rotation if the head and thorax are delivered and the problem is detected before severe impaction occurs. When the calf is dead and impacted, embryotomy to

remove the foetal head, neck and thorax and then to divide the pelvis longitudinally is a relatively simple and effective technique to release the foetus.

When traction applied to the oversized foetus has failed and has been abandoned caesarean section or embryotomy should be contemplated. Debackere et al. (1959) compared the results of the two techniques when used to deal with oversized foetus and noted that cow mortality was higher after embryotomy than after caesarean section. The cost of caesarean section was four times greater than that of embryotomy. Armstrong et al. (1978) listed the circumstances under which they considered caesarean section or vaginal delivery (including embryotomy) should be contemplated.

Caesarean Section

1. Alive oversized calf,
- 2) An alert strong cow,
- 3) Valuable but stressed calf,
- 4) Formidable embryotomy required,
- 5) Presence of uterine tear,
- 6) Posterior presentation.

Vaginal Delivery

- 1) Alive normal calf,
- 2) Dead calf,
- 3) Weak diseased calf,
- 4) Non-viable calf,
- 5) Favourable embryotomy possible,
- 6) Anterior presentation.

Prevention of Foetal Oversize

Various methods have been used to try to avoid the problem of foetal oversize. These have principally included:-

- a) attempting to breed a smaller calf by avoiding bulls known to sire calves larger than the breed average and strategic selection of bulls for use on heifers.

- b) selection of dams with large pelvic areas,
- c) reduction of food in late gestation,
- d) induction of birth.

Price and Wiltbank (1978a) advised that heifers with small pelvic areas should be culled and that the use of bulls known to sire large calves should be avoided. Tudor (1972) showed that whilst cattle maintained on a low energy diet produced calves of lower birth weight than those fed on a high energy diet, the poorly fed cows suffered dystocia caused by exhaustion and malnutrition. The author (Jackson, unpublished data) encountered problems in a Charolais herd in which losses attributed to foetal oversize had occurred. Severe restriction of the diet of heifers had been employed in the last month of gestation. Heifers approached calving in an extremely poor condition, with inadequate milk supply and little reduction in calf size. They also proved to be poor patients for the required caesarean section. Prior et al. (1979) noted 'The restriction of energy intake in the bovine female to a level that maintains maternal body weight has little influence on the development of the foetus even though maternal metabolism may be altered considerably by the level of energy intake'. Sloss and Dufty (1980) considered diet restriction to be of little value in preventing foetal oversize but warned that excessive diet with the risk of increasing the incidence of foetal oversize should also be avoided.

Induction of Birth

Noakes (1976), who reviewed some of the literature concerning induction of birth, noted that there were a number of indications for this procedure in addition to the prevention of dystocia due to foetal oversize. These included:-

- 1) Pre-determined calving related to the herdsman's duties,
- 2) Premature termination of pregnancy in cows suffering from hydrops, pericarditis or other life-threatening conditions.
- 3) Treatment of mummified foetus,
- 4) Synchronisation of group calving to suit pasture availability.

Induced birth is an unnatural phenomenon and Wagner et al. (1974) warned of some of the possible dangers and suggested that when induction was contemplated full discussion should take place with the

farmer beforehand. They suggested a code of conduct covering the following points:-

- 1) The cattle must be in good condition,
- 2) There must be adequate supervision of calving,
- 3) New born calves should be given assistance in sucking,
- 4) There should be a low incidence of disease on the farm,
- 5) Therapy for retained placenta should be available,
- 6) A small trial group should be monitored on the farm before full-scale induction.

Sloss and Dufty (1980) stressed the need for the above conditions and also the importance of accurate breeding records and they advised that a colostrum bank be set up where there was any risk of shortage. They also warned, as did Jackson (1979), that when birth was induced to avoid foetal oversize it did not preclude the development of other forms of dystocia. The two main groups of drugs which have been used to induce birth in recent years are the corticosteroids and prostaglandins.

Corticosteroids

Adams (1969 and 1970) observed that stressed cows often calved early and that abortion might follow the therapeutic use of corticosteroids in late gestation, and he attempted to use dexamethasone to induce birth experimentally. Using dexamethazone either alone or in combination with other drugs, he induced birth in nineteen of twenty-two cows dosed at 255 days of gestation. Placental retention occurred in twenty of the twenty-two animals. Other workers used dexamethasone in combination with oestradiol (Schmitt et al., 1975; Bolte et al., 1976 and Barth et al., 1978) but found that the addition of oestradiol did not alter the time to parturition or the incidence of dystocia. Garverick et al. (1974) considered the addition of oestradiol lowered the incidence of retained placenta. Barth et al. (1975) however, noted higher incidence of retained placenta whilst Levis et al. (1974) found no difference whether oestradiol was included or not.

Dexamethasone alone was used by Hansen and Christiansen (1971) and successful induction was achieved in ten out of sixteen cases. The drug was also used by Beardsley et al. (1974) to induce twenty-

five out of twenty-nine Holstein heifers at 273 days of gestation, 45.1 ± 11.1 hours after treatment. They noted a higher dystocia score among induced heifers than among untreated cows. The induced heifers did not appear to be fully dilated at calving and both retained placenta and milk fever were seen more frequently in induced animals. Good relaxation was however noted within twenty-four hours of administration of dexamethasone by Lindell et al. (1974) in a cow which was twenty days beyond its prospective calving date.

Dexamethasone trimethyl acetate (dexamethasone T.M.A.) has been used alone or in combination with other drugs for the induction of birth. The drug, a so-called long-acting corticosteroid, was used by Bailey et al. (1973) who noted that it was associated with a lower incidence of retained placenta than was dexamethasone. Birth was induced four to twenty days after treatment in animals at between 240 and 252 days of gestation. Welch et al. (1973) commented on the widespread use of dexamethasone TMA in New Zealand to induce birth to coincide with pasture availability. O'Farrell and Crowley (1974) used the drug both alone and in combination with prednisolone but found the response to both preparations was very variable and considered that this greatly limited their value. Kelly et al. (1973) administered 25 mg of dexamethasone TMA plus 7.5 mg prednisolone to induce birth in twenty animals in which foetal oversize was anticipated. The majority of cattle were over 281 days pregnant and some were at day 287 of gestation. Birth was successfully induced within twelve to sixty-five hours and no problem with retained placenta was recorded. In their trial Welch et al. (1973) reported a high incidence of calf mortality with up to 40 per cent of the calf crop being lost on some farms. In a trial involving Charolais cattle Holden and Reader (1979) successfully avoided problems of foetal oversize by inducing cattle at 275 days of gestation with dexamethasone TMA. If birth had not occurred by 282 days of gestation, 20 mg of betamethasone was given and in all cases birth occurred within forty-eight hours of this second injection. An aqueous solution of mixed dexamethasone esters was used by Allen and Herring (1976) and by Terblanche et al. (1976) to induce calving to coincide with seasonal grazing in Australia and to avoid foetal oversize in South Africa respectively.

Plenderleith (1974) noted that veterinary surgeons were often presented with a fait accompli of heifers in calf to exotic bulls. Following disastrous results from such matings he reported this successful use of 20 mg of betamethasone to induce calving seven hours to six days post-treatment and stressed the need for careful supervision of both the cow and the calf. O'Farrell and Langley (1975) successfully used 40 mg of betamethasone to induce birth in cattle at between 255 and 288 days of pregnancy. Thirty-three of forty-four responded within five days of treatment but a high incidence of retained placenta was noted. The authors considered the response to betamethasone was more predictable than that seen following the use of the longer-acting corticosteroid. In a later study Langley and O'Farrell (1976) found that, despite some reports to the contrary, the immune status of the calves following induced birth was not deficient. Welch et al. (1977) found that increasing doses of betamethasone given at two-day intervals was an efficient method of inducing birth within nine days of the first treatment, but recognised that such repeated injections were impractical under farm conditions. Betamethasone alcohol suspensions were found to be more effective than dexamethasone TMA in inducing birth by MacDiarmid, 1979, 1980).

Flumethasone has also been used to induce birth in cattle, one of the earliest reports being that of Ficarelli et al. (1970) who used the drug to hasten the onset of parturition in cows suffering from traumatic reticulitis. Other users of flumethasone included Wagner et al. (1971, 1974), Lauderdale (1972), Welch et al. (1973) and Kordts and Jochle (1975). Wagner et al. (1974) reported that a combination of 60 mg of dexamethasone and 7.5 mg of flumethasone induced birth in 100 per cent of cases within seventy-two hours of administration. Single and double régimes using flumethasone were reported by LaVoie et al. (1975). They noted a higher incidence of dystocia in groups of beef heifers receiving two doses of 5 mg of flumethasone at twelve-hour intervals, eight to thirteen days before calving than in those receiving a single 10 mg dose. No case details were given.

Prostaglandins

The luteolytic activity of prostaglandin F_{2α} and its synthetic analogue cloprostenol has been shown to cause abortion in cattle up to day 150 of pregnancy (Jackson and Cooper, 1977), but a number of authors have found that parturition may also be successfully induced using these drugs in a high percentage of cattle between days 150 and 200 days of gestation (Murray et al., 1981).

Carter and Parsonson (1976) used doses of 500-2000μg of cloprostenol to induce birth in cattle at days 254-267 of gestation and found that the incidence of retained placenta and stillborn calves was higher than in untreated controls. Further results were described by Johnson and Jackson (1980), who reported that they found no difference in the incidence of dystocia in induced and untreated animals. A later trial by these authors (Johnson and Jackson, 1982) found that intravenous administration of the drug had no advantage over intramuscular injection.

Plenderleith (1978) reported successful induction of birth in dairy heifers using synthetic prostaglandin F_{2α} dinoprost, but placental retention occurred in up to 25 per cent of cases. In one trial, however, Plenderleith recorded an incidence of 75 per cent dystocia which he attributed to an excessively zealous stockman as he reported better results on other farms using the same treatment régime. He considered that there was little difference in efficiency between dinoprost and the corticosteroids.

A number of other combinations of drugs have been used to induce birth in cattle. Hendricks et al. (1975) considered that a combination of prostaglandin F_{2α} and oestradiol reduced the incidence of retained placenta when compared with prostaglandin given alone. Beal et al. (1976) found that cattle induced with dexamethasone followed 40 hours later by prostaglandin F_{2α} calved significantly earlier than those treated with dexamethasone alone. In another trial Welch et al. (1979) compared the action of two dexamethasone esters (dexamethasone trimethyl acetate and dexamethasone isonicotinate) followed, if parturition did not occur within seven days, by either betamethasone or cloprostenol. They found no difference between the activities of the dexamethasone esters but the time to calving was found to be both more predictable and shorter after cloprostenol than after betamethasone.

Murray et al. (1981), noting the difficulty of inducing birth between days 210 and 240 of gestation in heifers accidentally mated, used a régime consisting of an injection of 20 mg dexamethasone phenylpropionate followed eleven days later by 500 µg cloprostenol. Birth occurred within 48 hours of the second injection but a high incidence of retained placenta was recorded.

In a study of induced termination of pregnancy in a large New Zealand herd, Day (1979) used cloprostenol, dinoprost or dexamethasone either alone or in combination. He observed that dinoprost was associated with rapid delivery but also with a high incidence of dystocia caused by failure of the cervix to dilate fully. He found the use of the drug produced satisfactory results when given within two weeks of term but in earlier pregnancies advised that its use should be preceded by dexamethasone injection.

The numerous combinations of drugs which have been used to induce birth in cattle suggest that perhaps none is wholly ideal. Diskin et al. (1982) considered that there were two main problems to be overcome to achieve satisfactory induction of birth in cattle. These were (a) insufficient time for adequate preparation of the birth canal and (b) retention of the placenta. They attempted to avoid these problems by administering 25 mg betamethasone alcohol at 280 days gestation followed five or six days later by 30 mg betamethasone phosphate or 25 mg dinoprost. They reported adequate cervical dilation, good milk supply and a low incidence of retained placenta.

The author of this thesis has found that the unpredictable time of response when using most régimes of therapy has caused great problems of management and supervision. When these problems can be successfully overcome, induction of birth may become a more reliable and satisfactory method of avoiding dystocia caused by foetal over-size in cattle.

CHAPTER ELEVEN

DYSTOCIA CAUSED BY FAULTY FOETAL DISPOSITION

In normal birth the bovine foetus is in anterior presentation, dorsal position and in a fully extended posture (Sloss and Dufty, 1980). For unimpeded delivery of the foetus these authors considered that optimal myometrial tone and contraction were essential as was the ability of the foetus to respond in a reflex manner to changes of uterine tone and tension. The tone of the uterus might in turn be related to the prevailing levels of plasma progesterone. Arthur et al. (1982) considered that the posture adopted by the foetus at birth was remarkable as it was never again adopted during the subsequent life of the calf.

According to Fraser and Herschen (1978) the foetus adopted an 'alerted posture' as birth approached and Arthur et al. (1982) suggested that the adoption of this posture was probably practised on numerous occasions as birth approached. A lack of foetal exercise might lead to a reduced ability to assume the correct posture (Sloss and Dufty, 1980).

Hindson and Turner (1966) believed that lack of space in the uterus and random foetal movements might cause the foetus to adopt an abnormal posture at the time of birth. Foetal anoxia might cause sudden abnormal foetal movement or lead to the death of the foetus in an abnormal position. Once the foetus was engaged in the maternal pelvis in an abnormal disposition, correction of the abnormality without human aid was most unlikely (Sloss and Dufty, 1980).

Arthur et al. (1982) considered that the assumption of abnormal presentation was likely to occur in the sixth to eighth month of gestation after which time lack of space tended to prevent the presentation of the foetus from changing. Abnormalities of position and posture were likely to occur during the first or the second stages of labour. Lack of foetal vigour was considered to predispose to foetal maldisposition according to Williams (1943), whilst Mitchell (1939) considered that an adverse foetal environment, such as might be found in a brucella-infected uterus, also predisposed to postural abnormalities.

Fleming (1877) noted that foetal maldisposition occurred more frequently in the cow than in other species, a fact which he attributed to the long neck and legs of the foetus together with the long narrow maternal pelvis. Foetal maldisposition is an important cause of bovine dystocia and in early texts much space was taken in descriptions of malpresentations, maldispositions and malpostures with detailed accounts of the methods which might be employed when dealing with them (Fleming, 1877; Benesch, 1938).

Any departure from the normal disposition of the foetus at birth may result in dystocia. Malpresentation, malposition or malposture may occur either alone or in combination as causes of dystocia. A large number of individual abnormalities have been described and summarised (Arthur et al., 1982) as follows (Table 8):-

Table 8 Abnormalities of foetal disposition

A. Malpresentation

Posterior

Vertical

Transverse

B. Malposition

Ventral*

Lateral* (Right or Left)

* Note Fleming (1877) preferred the term 'dorso-pubic' to describe a foetus in ventral position and the term 'supra-cotyloid' to describe lateral position.

C. Malposture

a) Anterior Presentation

(i) Head

Downward deviation

Lateral deviation

Upward deviation

(ii) Fore limbs

Carpal flexion

Elbow flexion

Shoulder flexion

b) Posterior Presentation

(i) Hind limbs

Hock flexion

Hip flexion

According to Cartwright (1846a) the malpostures of downward or lateral deviation of the foetal head were frequently seen and a search of the literature has highlighted the importance of these abnormalities together with hip flexion and shoulder flexion.

Foetal maldisposition may directly result in dystocia or may be a further complication of another cause of dystocia. Following correction of uterine torsion, foetal maldisposition has been recorded on a number of occasions (Parker, 1891; McIntosh, 1894; Knowles, 1901; Collett, 1922). In three of these cases lateral deviation of the foetal head was seen. Foetal maldisposition may also be seen in cases of multiple-birth. Siemer (1931), who described a case of dystocia involving the birth of quintuplets, found that the first calf was in bilateral shoulder flexion. Foetal maldisposition complicating cases of twin birth has also been recorded on a number of occasions (Nelson, 1849; Wyssman, 1933; Daerr and Grünert, 1970). Hall (1889) and Wardrop (1928) both described dystocia caused by conjoined twins in which malpresentation was an additional complication. Other problems in which foetal maldisposition has been a further complication have included cervical obstruction (Drouard, 1842), dystocia attributed to 'placenta praevia' (Younghusband, 1854a), foetal oversize (Edwards, 1946) and following induction of birth (Jackson, 1979).

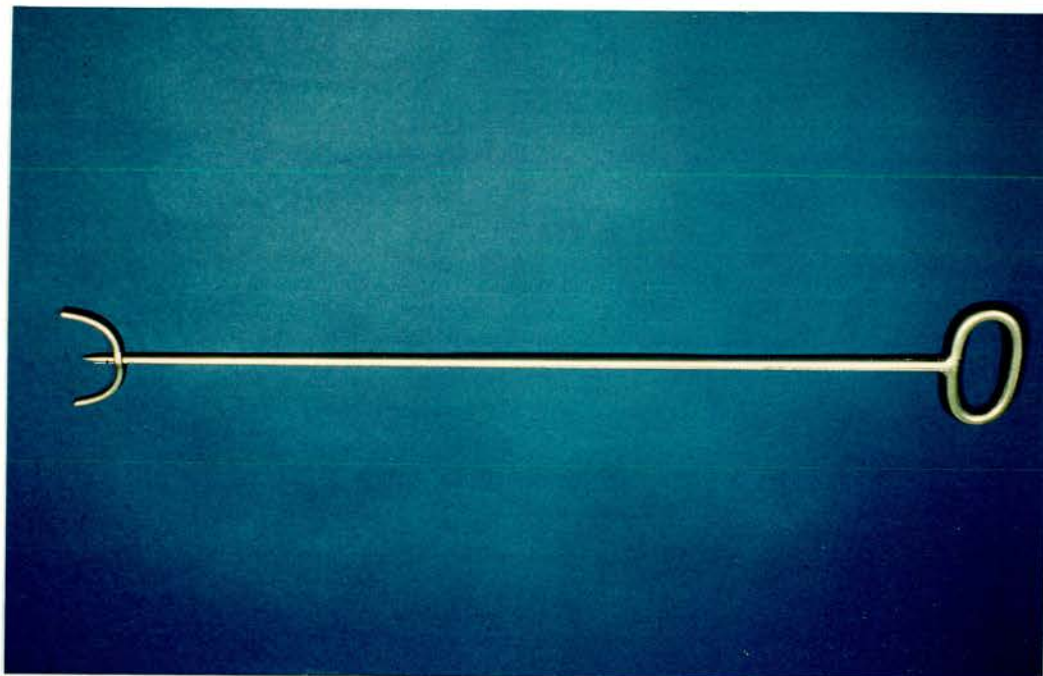
The diagnosis of foetal maldisposition can present difficulties especially in neglected cases and Parker (1921) recalled a case of breech presentation which he mistook for twin calves having palpated both hind and fore limbs in close proximity. Numerous examples of lay interference involving maldisposed foetuses have been recorded. Cox (1841) recorded being called to a case of unilateral shoulder flexion in which the owner had attempted correction promoting profuse haemorrhage and described how he dealt with the problem by introducing 'black oil' into the uterus and drenching the cow with a mixture of magnesium sulphate, digitalis, nitre and caraway powder. The cow recovered but later her skin became yellow and her hair came away in patches.

Repulsion of the foetus into the uterus is an essential preliminary to attempting to correct foetal maldisposition. Farrow (1865) noted 'where there are parts in the vagina, they should first be

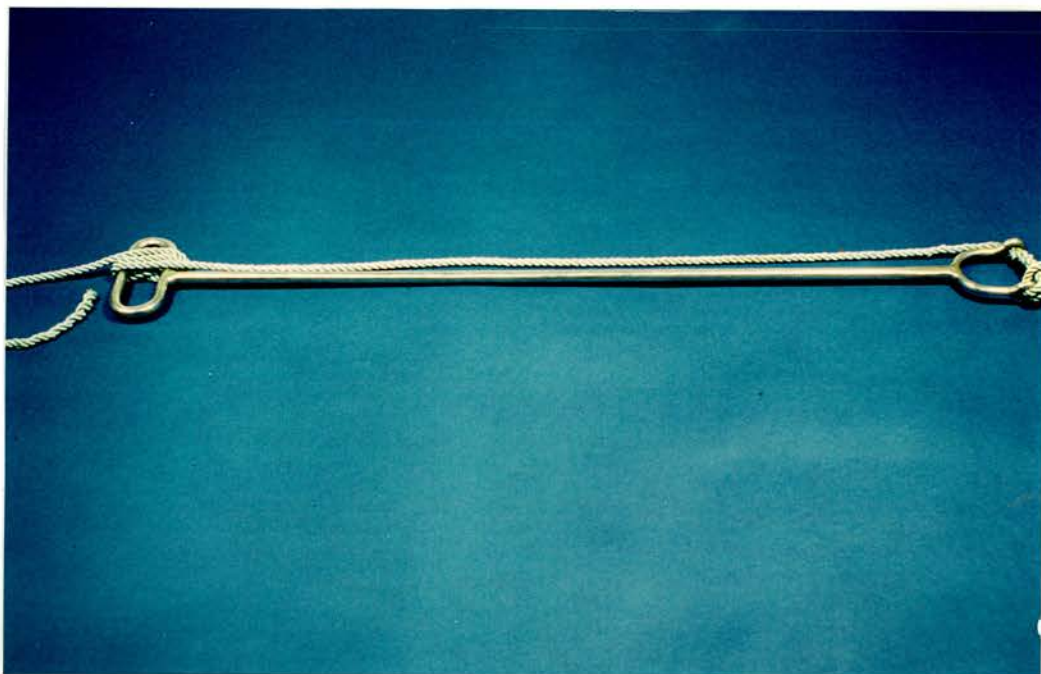
returned into the uterus. They should then be replaced in the order intended by nature, that they should pass through the pelvis'. Repulsion was especially important when dealing with breech presentations according to Sloss and Dufty (1980) who noted that the arc described the foetal foot during the correction of hip flexion was much greater than that described by the forelegs in the correction of carpal flexion. Repulsion can be achieved either by manual pressure, often aided by epidural anaesthesia or by the use of instruments designed for that purpose. Illustrated below is a repeller (Plate 17) and also Kuhn's crutch (Plate 18), both of which may be used to apply pressure to the foetus during its repulsion.

Where possible the cow should be encouraged to stay on her feet, thus avoiding the abdominal pressures associated with recumbency (Bedel, 1903a; Sloss and Dufty, 1980). If the cow is recumbent, physically raising her hindquarters has been recommended by a number of authors (Barlow, 1846; Cartwright, 1846b; Farrow, 1865; Munro, 1894a; Anon., 1903; Anon., 1920; New, 1920; Caton, 1921; Pierce, 1923; Parker, 1982). New (1920) proposed that the cow's hindquarters should be raised at least five feet above the ground but other authors warned of the dangers of uterine rupture if the hind end of the cow was even slightly raised. Michelat (1966) advised that, should the cow be recumbent, her hind legs were best pulled out behind her and considered that the adoption of this position would give equal mobility of movement within the uterus as would elevating the hind end of the cow.

Although most cases of foetal maldisposition may be dealt with by manual means, Pollock (1898), a Norfolk practitioner, devised a series of instruments which he used in such cases. His 'porte-sping band' was a flexible steel strip bent in the form of a circle with loops at either end. The author (Jackson, unpublished data) has used this instrument to great effect in passing ropes or embryotomy wire around a deviated foetal head or leg. Pollock invented numerous other instruments including his 'ear or nose forceps' used for reaching a deviated head. His 'obstetrical harpoon' was used to pierce the foetal thorax or abdominal cavity with self-fixing action, allowing parts of the foetus to be brought closer to the operator or further manipulated.

PLATE 17

Obstetrical Repeller - the sharp central point is detachable and should be removed if the instrument is used to repel a living foetus.

PLATE 18

Kuhn's Crutch - this instrument may be used as a repeller or, when used in conjunction with a calving rope (as illustrated), to manipulate foetal limbs in utero.

The prognosis of cases of maldisposition was discussed by Sloss and Dufty (1980). They considered that the progress made depended upon the condition of the foetus, the state of the birth canal and the general health of the dam. They warned that in cases of foetal maldisposition the foetus had often been subject to hypoxia and might have suffered some permanent damage in utero with grave consequences for its subsequent viability.

Some of the more frequent forms of foetal maldisposition will be considered under separate headings below:-

A. Malpresentation

i) Posterior Presentation

Posterior presentation has been considered abnormal by some authors (Williams, 1943; Sloss and Dufty, 1980). The former author warned of the dangers to the foetus of hasty intervention in such cases while Sloss and Dufty noted that dystocia was up to seven times more likely to occur when the foetus was in posterior presentation. These authors also unfavourably contrasted the abruptly widening posterior part of the foetus to the wedge-shaped anterior presentation in the natural process of dilation of the birth canal.

ii) Vertical Presentation

Cartwright (1845a) in a series of articles on his experiences of veterinary obstetrics described being called to a case in which the foetus appeared to be 'stuck at its hips'. Examination revealed that the foetus was in the 'dog sitting position' and that the hind limbs were present in the pelvis. Cartwright removed the anterior portion of the calf by embryotomy and repelled the hind limbs before delivering them. Similar cases were described by Munro (1894a), Findlay (1897) and Edwards (1923) but the paucity of recorded cases suggests that this malpresentation is relatively uncommon.

iii) Transverse Presentation

In this abnormal presentation the foetus lies transversely across the pelvic inlet and may present either its backbone or its extremities towards the pelvis and may be described as either dorso-transverse or ventro-transverse presentation respectively. Lechner (1978) in a survey of bovine dystocia cases seen by Bavarian veterinary practitioners

estimated that transverse presentation was responsible for approximately 0.046 per cent. An interesting case of transverse presentation in the second member of a pair of twins was described by Miller (1863). The foetus, in dorso-transverse presentation, was emphysematous and Miller was able to divide the vertebral column and the body of the foetus using a penknife before delivering the two halves separately. Smith (1884) also used embryotomy to divide a foetus, this time in ventro-transverse presentation.

Crichton (1902) offered general advice on the best method of dealing with a transverse presentation. Where possible he considered that the front end of the foetus should be repelled and the calf should be delivered by traction applied to the hind limbs. Padmanabhan (1925) who was called to a case of a transverse presentation which had been seven days in labour, successfully performed caesarean section under chloroform anaesthesia.

B. Malposition

A number of dystocia cases caused by calves being presented in ventral position have appeared in the literature. Cartwright (1842a) recalled one such case complicated by foetal emphysema in which traction by means of hooks and partial embryotomy were required to effect delivery. Later the same author (Cartwright, 1846a) stated that occasionally calves in ventral position might be delivered by the cow unaided. Where traction was required it should be applied in an upward direction in order to prevent the foetal head being displaced below the pelvic brim. This particular problem was encountered by Nelson (1847) and by Jones (1881). Nelson performed embryotomy to deliver his case while Jones managed to correct the head displacement manually and deliver a living calf.

Rotation and traction of the foetus were recommended for the treatment of ventral malposition by Gilani (1891) but when the foetus was grossly emphysematous such a technique might be impossible (Pafin, 1903). The author (Jackson, unpublished data) has found that rotation cannot always be successfully performed especially when fetal fluids have been lost and the uterus has contracted tightly upon the foetus. In such cases traction has been applied, combined with simultaneous rotation to restore the foetus to its correct position.

The cases described above have involved calves in anterior presentation but occasionally ventral malposition is encountered in calves in posterior presentation (Younghusband, 1854b).

C. Malposture

Foetal malposture may involve either the head or limbs or a combination of both. Correction of the malposture, provided it can be reached, is normally achieved by (a) repulsion of the foetus and (b) grasping the offending head or limb and returning it to its normal posture. During this manoeuvre great care must be exercised to avoid damage to the uterus.

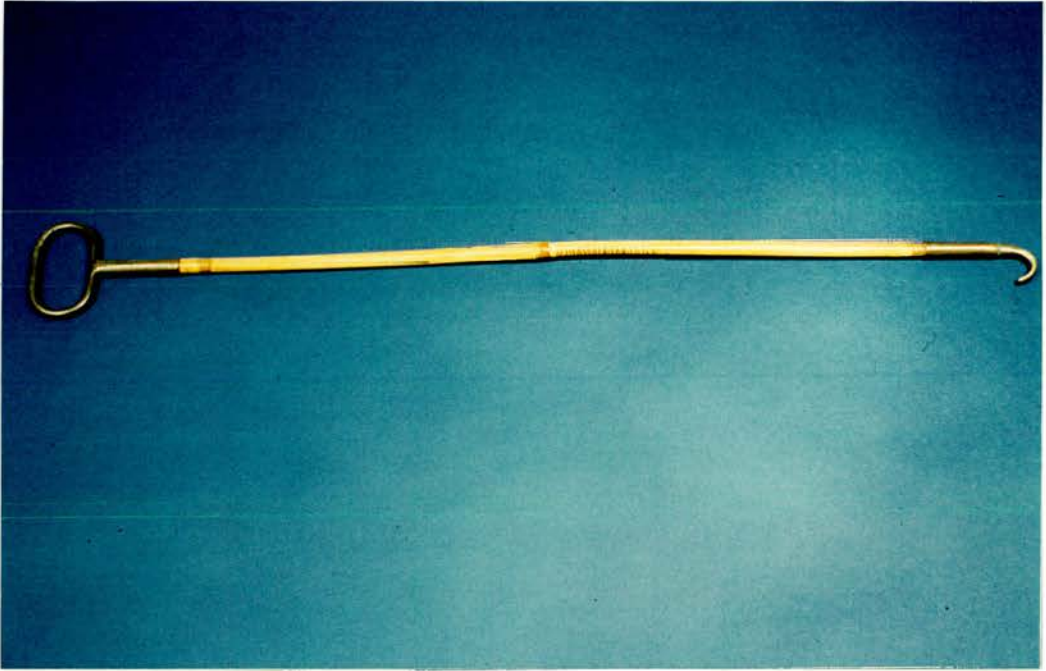
i) Lateral Deviation of the Head

In this malposture the foetal head is turned laterally and may lie adjacent to the thorax. Occasionally such malposture may be complicated by a rotation of the fetal head (Goldsmith, 1930) or by the condition known as 'wry neck'. In the latter malposture (Cartwright, 1846a; Williams, 1943) the deviation is permanent.

DeNooij (1981) warned of the risk of uterine rupture which might occur especially in the dorsal uterine wall during correction of lateral deviation of the head. Dandrieux (1836) and Cartwright (1842b) encountered cases where they suspected that lay interference had produced uterine rupture. Cartwright noted that a calf with a deviated head had been delivered by a 'rash athletic man' leaving a uterine tear resulting in the slaughter of the cow. Gamgee (1858) and Parker (1914) described similar cases as, more recently, did Pascoe (1968).

Some difficulty may be encountered in finding the deviated head (Parker, 1915c) and epidural anaesthesia may be necessary to prevent maternal straining whilst the head is retrieved (Stinson, 1930b; Tutt, 1944). Instruments may be used to aid retrieval of the head. Canu (1838) unsuccessfully used a crotchet inserted into the orbit in an attempt to retrieve a deviated head, whilst Blanchard (1906) found his light flexible cane-handled hook (illustrated below, Plate 19) of great assistance in such cases. Beeson (1881) advocated the use of his 'ear clamp' in cases where the ear was the only part of the deviated head palpable.

In cases where the calf is dead or the head deviation cannot be corrected, embryotomy may be performed to divide the head and part

PLATE 19

Blanchard's hook - the long flexible instrument has been used in correction of lateral deviation of the foetal head.

of the neck from the body of the foetus thus allowing delivery of both portions. Herr (1979) advised that the neck should be severed low down between the scapulae. No stump of the neck would remain using this method and the diameter of the foetus at the shoulder would thus be greatly reduced. Edwards (1923 and 1925) preferred to use a chisel to sever the cervical vertebrae but such a procedure must have been extremely risky and liable to damage maternal tissues.

Attempts have been made to deliver the foetus with deviated head by traction without correction. Thibaudeau (1831) attempted such treatment in a twenty-year-old Breton cow but failed and finally resorted to embryotomy. Cartwright (1846a) noted that such a method had been attempted but remarked 'I hope no veterinary surgeon in the present day, who has any character for humanity will dare to torture an animal whilst means are at his disposal to avoid it'. Fleming (1877) expressed similar sentiments. Reeks (1922 and 1923) noted that whilst such a procedure was possible in the foal, the shape of the bovine foetal head precluded such methods.

In most cases the veterinarian is able by manual means to correct the deviation of the head but such a technique is not always achieved by the layman. Cartwright (1855) was called to deal with a case in which 'a man who pretended some knowledge in these matters had been with the animal for the greater part of the day, but could not remove the calf and he stated that in his belief it was impossible for anyone else to do so'. Cartwright examined the animal, found that one leg of the foetus had been removed and by manipulation managed to deliver the calf from the dying cow.

Cases of successful delivery by manipulation were described by Nelson (1849) and by Jorgenson (1921). Stevens (1929) retrieved a deviated head with the aid of a calving rope gradually slipped along the neck towards the foetal head, before traction was applied. Dabert (1929) and MacColl (1929) both advised rotating the foetus into a lateral position, casting the cow and retrieving the head from above using gravity to aid its recovery.

ii) Downward Deviation of the Head

Deviation of the head in a downward direction is less frequently encountered than lateral deviation and may be accompanied by a high level of foetal mortality (Rowlands, 1812). Tait (1834) successfully dealt with such a case by repulsion followed by raising the head with his fingers in the foetal eye-sockets. Tait's arrival was apparently fortuitous as the 'local leech' was about to perform a caesarean operation. Eyehooks were illustrated by Gilani (1891) to raise a downward deviated head. The use of long-handled hooks was described by Heatley (1932a). Upward deviation of the head in the calf in dorsal position is an uncommon occurrence.

iii) Carpal Flexion

This malposture may involve one or both forelimbs and is normally corrected by repulsion and manual retrieval of the affected limbs (Burgon, 1934). Benesch (1938) described a number of methods involving the use of calving ropes to retrieve the displaced limb. When only one limb is affected the head and the remaining limb may protrude from the vulva (Bruce, 1896).

Bossenberger (1915) described a case in which the foetus with one leg in carpal flexion was grossly putrefied and in which the offending limb separated from the body when an attempt was made to

correct its position. Lubrication followed by severe traction was required to deliver the foetus. Another complicated case was described by Lax and Drew (1974). In this case the farmer had successfully dealt with the carpal flexion but the cow developed milk fever and suffered a fall which resulted one week later in death from peritonitis associated with a ruptured bladder.

iv) Shoulder Flexion

This form of malposture may also involve either one or both limbs and was described by Herr (1979) as being 'one of the most common forms of dystocia'. In some cases the foetal head protrudes from the vulva and may become enlarged and oedematous as a result of pressure being applied by the vulval lips and the soft tissues of the birth canal. Repulsion to allow room to retrieve the forelimbs may be difficult in such circumstances but can mostly be achieved with adequate lubrication and, if necessary, epidural anaesthesia. Simonds (1849) advised that the veterinarian should not attempt to replace the foetal head even if the calf was alive, but should remove the head to destroy the calf before repelling the foetus. Such advice would currently be quite unacceptable.

Manual retrieval of the limbs is usually possible even in small cows (Vogel, 1972) but Nelson (1849), in a case allegedly three months overdue, corrected the malposture but had to perform embryotomy to remove the dead emphysematous foetus. Following correction and delivery of a case of unilateral shoulder flexion Tutt (1919) encountered severe uterine haemorrhage. He was unable to locate the source of bleeding but successfully dealt with the problem by administering an injection of adrenalin.

In cases where the foetus is dead and foetal fluids have been lost, amputation of the head will be required to allow its repulsion. Hodgson (1891) and Parker (1915b) both described cases in which this action was necessary. Herr (1979) advised that the point of amputation should be low down the neck between the shoulder blades for reasons already discussed above. Amputation at the atlanto-occipital joint which is more easily accessible outwith the confines of the vagina is usually satisfactory.

v) Hock Flexion

Unilateral or bilateral flexion of the tarsal joints may be found as a cause of dystocia in the posteriorly presented foetus. In unilateral cases the unaffected limb may protrude from the vulva whilst in bilateral cases the hind limbs may be crossed in the metatarsal region (Sloss and Dufty, 1980). Correction of the malposture is accomplished by repelling the foetus and holding the limb in flexion whilst retrieving the foot of the deviated limb. The foot is cupped in the operator's hand to avoid uterine damage and lifted over the pelvic brim before being extended in the vagina. The procedure may be facilitated by epidural anaesthesia (Arthur et al., 1982).

Fleming (1877) noted that a small or narrow maternal pelvis might make retrieval of the deviated limb difficult whilst Sloss and Dufty (1980) observed that the large arc of movement described by the foot during its return to normal position increased the risk of uterine rupture. De Bruin (1901) stressed the need for great care during the manipulation in view of the extreme fragility of the ventral uterine floor. Earlier however Horsburgh (1846a) had, perhaps incautiously, suggested that the 'spongy substance of the hooves' rendered the procedure free of risk.

Smith (1884) and Davis (1921) advised that the obstetrician should use his hands only to retrieve the deviated limb although on occasion a porte-cord might be useful to carry a calving rope to the foot of the deviated limb. Tudor-Hughes (1922) and Benesch (1938) gave detailed descriptions of how the 'opposing forces' of the hand and a foot snare might be used to retrieve the limb. The looped calving rope was placed around the calf's leg just below the fetlock joint and the end of the rope brought up between the claws of the foetal foot. Traction was applied to the foot whilst the operator repelled the foetal hock. Further methods involving the use of Kuhn's crutch were also described by Benesch. Occasionally manipulative delivery may be unsuccessful and in such cases, if the foetus is dead, the deviated limb may have to be severed by embryotomy below the hock joint.

vi) Hip Flexion

This malposture which occurs in the foetus in posterior

presentation was described by Fleming (1877) as 'thigh-croup presentation'. The term breech or 'breach' is however generally used. Fleming stressed the ominous nature of this malposture noting that the mother frequently 'perished without being delivered'. The large number of references to this malposture in the literature suggests that it is one of the more common types of maldisposition of the foetus. The severe difficulties encountered during correction may also have contributed to its frequent description. These difficulties are particularly apparent when breech delivery is attempted by the layman who may do considerable damage. Edwards (1923) questioned 'Is there any presentation in which as frequently the local handyman produces a ruptured uterus by his efforts as in the breech?'. Hopkins and Amor (1964) and Pascoe (1968) considered that uterine rupture was particularly likely to accompany breech presentation.

The external appearance of a breech presentation may be simply that the foetal tail appears at the vulva or alternatively nothing is seen and the malposture is discovered on vaginal examination. Delivery of the breech presentation without correction has been reported although it cannot be recommended. Bedel (1906) and Hopkins and Amor (1964) suggested that it could be achieved especially with small calves, whilst Edwards (1923) believed that small calves might be delivered unaided by the mother in uncorrected posture. When uncorrected delivery was contemplated, traction was applied to the foetus via cords inserted between the thighs or alternatively around the foetal body (Fleming, 1877). Such traction might cause abduction of the foetal limbs rendering delivery more difficult. Alternatively crotchets could be hooked into the foetal muscles but if they slipped severe uterine damage might result.

Tremendous force was sometimes employed to deliver uncorrected breech presentations in normal sized calves. Cartwright (1845a) described a case in which a farrier delivered a breech presentation by forced traction which resulted in the death of the cow. In another case Cartwright (1855) was called to a cow from which six inches of the calf protruded, the birth canal was well dilated and the uncorrected calf was delivered by mild traction. He was rather fortunate to avoid serious injury in another case (Cartwright, 1865a and b) in which he managed to bring one leg into the vagina but could

only convert the second leg into the hock-flexion posture. Forced traction was then applied to deliver the foetus and surprisingly no vaginal or uterine lacerations were detected.

Gregory (1877) also reported delivery of a breech presentation calf by forced traction in a heifer, but three men pulled for forty minutes before delivery was achieved. Davis (1924a) employed an anal hook to deliver a calf successfully by traction but also needed the help of three men to do so. Edwards (1923) discussing bovine and equine obstetrics noted 'taken however at full term as an obstetrical procedure the method of forced extraction strikes me as being so unsurgical, not to say barbarous and to reveal such paucity of surgical resource as to justify the layman linking us with the empiric'. Two cases have been described in which the calf was successfully delivered after the retrieval of one leg only (Anon., 1920) but both calves died as a result of prolonged compression of the foetal chest during delivery.

Repulsion of the foetus is an essential pre-requisite to correction of the breech malposture. The difficulty of both repelling the foetus and of dealing with the deviated limbs without the aid of a surgical repeller may require the use of two arms. As a veterinary obstetrician might find difficulty in inserting both his arms into the vagina at once, the problem might be solved, it was suggested, by the operator and his assistant standing back to back and using their right and left arms respectively (Cartwright, 1842a; Barlow, 1846; Cartwright, 1846b; Anon., 1920 and Squair, 1921a). New (1920) disapproved of the procedure considering that there was insufficient room within the vagina whilst Davis (1921) warned of the dangers of vaginal bruising. Nelson (1848) had described a case in which, despite care, severe vaginal laceration had taken place.

The use of repellers in the treatment of breech malposture was advocated by a number of authors (Barlow, 1846; Merrick, 1851; McKenny, 1903 and Davis, 1921), but Horsburgh (1846b) considered such instruments too dangerous to use. Wardrop (1921) claimed to have invented an instrument which would repel the foetus, search for the limbs, turn the foetus in utero and then withdraw it - the whole procedure being without risk.

Manipulative delivery requires the hindlimbs to be converted

firstly into the hock flexion posture and secondly into the extended posture of posterior presentation. The latter procedure has already been discussed during consideration of dystocia caused by hock flexion. Conversion of hip flexion to hock flexion must now be considered. Foetal repulsion, aided if necessary by epidural anaesthesia, is followed by the operator grasping the limb as near to the hock as possible. Traction on the limb in a caudal and upward direction will convert the posture into hock flexion.

Crichton (1902) considered that the limbs should be brought up to the pelvis in as lateral a position as possible to allow maximum room and lessen the risk of uterine damage. If the calf was in lateral position Davis (1921) found that it was more advantageous to retrieve the lower limb first.

Once the limbs have been placed in their correct position, traction is applied to the foetus. As with all calves in posterior presentation, Cartwright (1850b) warned that the direction of the foetal hair would increase the friction to traction and Munro (1894a) advised that the calf's tail must not be allowed to double over the calf's back thus further increasing resistance to its delivery. Hay (1861) having corrected a dead breech presentation found that severing the foetal achilles tendon would allow greater extension of the stifle joint and hence increase the ease of the delivery.

In cases in which the breech malposture cannot be corrected, embryotomy to remove one or both hind limbs may be required to allow delivery. Brooksbank (1932) used a wire saw to remove one foetal leg thus allowing room for the second leg to be corrected manually and traction to be applied. This technique for hindlimb amputation has been described in detail by Arthur et al. (1982). Cartwright (1842a) suggested that 'cropping shears' might be useful to remove the lower portions of the offending limbs. Horsburgh (1846a) reported on the technique of femoral head disarticulation, a technique which was later used with success by Edwards (1923, 1924a and 1925). Edwards noted 'many a time on a cold winter's night, rather than strip for a retroversion in the breech of a dead calf I have done a 'femoral' simply because I could do it with my shirt sleeves rolled up and be on the road home sooner'. His technique was to cut down onto the femoral head, free it from its articulations and apply traction to it

and by incising the skin and muscles remove the femur from within the tissues of the thigh. In the case of the dead or emphysematous calf piecemeal removal of the foetus may be possible (Cartwright 1861b).

Symphysiotomy or dissection and destruction of the foetal pelvis and femoro-coxal articulations were proposed as alternative procedures by Fleming (1877). More recently the use of a long cutting hook to fracture the foetal pelvis was described by Graham (1979).

An interesting case of breech presentation was reported by Metherell (1883) in which the foetus had no tail and from which the lumbar vertebrae were missing. Embryotomy was required to remove the hindlimbs and allow delivery and it is possible although not certain from the description that this was in fact a foetal monster of the perosomus elumbis type. Another somewhat unusual case was described by Keatinge (1938). Commenting on the ability of the cow to withstand great adversity, Keatinge noted that his case had suffered successively red-water fever, breech presentation, milk fever and retained foetal membranes. Despite all these problems she had made a successful recovery.

CHAPTER TWELVE

DYSTOCIA CAUSED BY FOETAL MONSTERS

Foetal monsters were described in the words of Fleming (1877) as 'some remarkable anomaly or organic deviation in form or structure or both in one or more parts of the body'. Fleming also remarked upon the interest and anxiety with which foetal monsters were regarded. They were 'ascribed to the influence of enraged gods and were regarded with fear or horror or they were looked upon as prodigies and freaks of nature and described as marvels or curiosities'. A more scientific attitude to foetal monsters began, according to Fleming, at the beginning of the 19th century but it is apparent when perusing reports even in the early 20th century that foetal monsters were still regarded with awe by some farmers and their veterinarians. Scott (1912) suggested that foetal monsters might be caused by emotional disturbance. Noting that the gravid uterus was in 'intimate touch' with the central nervous system he considered that the latter system was in an 'abnormally sensitive state' during pregnancy and therefore especially impressionable to extraneous influences. He recalled seeing three cases of *Schistosomus reflexus* born to heifers on a local farm and attributed the abnormalities to the fact that the heifers had been frightened by two men and a dancing bear which had spent the night in the heifers' field. Williams (1931a), however, considered that most monsters were the result of embryonic disease prior to the development of the foetal organs.

In a most interesting and informative article Leipold and Dennis (1980) reviewed the problem of congenital defects affecting bovine reproduction. In their opinion, approximately one-third of all defects were inherited, one-sixth were associated with virus infection and the remainder were due to environmental causes. The malformed calf was 'an adapted survivor from a disruptive event at one or more stages in the complexly integrated process of embryonic or foetal development'. During the pre-attachment stages of the embryo (days 0-14 of gestation) the embryo was susceptible to genetic mutations but resistant to teratogens. In the embryonic stage (days 14-42) the conceptus was very susceptible to teratogens. After day 42 organogenesis was almost complete and the foetus was less susceptible to teratogens with the

exception of the areas of late differentiation which occurred in the cerebellum, palate and urogenital system.

Although foetal monsters are relatively uncommon their unusual nature has perhaps accounted for the disproportionate amount of attention they have received in the literature. The author has noted some 150 references to dystocia caused by foetal monsters during the past 170 years and it is interesting to note that approximately 70 per cent of these references were written prior to the year 1930.

Fleming (1877) observed that in Britain no classification of foetal monsters had been proposed and he recommended those of St Hilaire and Gurlt for consideration. Of the two, he favoured that of Gurlt which divided monsters into two classes: a) simple and b) compound monsters. The simple monsters were subdivided into 8 'orders', 26 'genera' and 73 'species' and the compound monsters into 6 'orders', 26 'genera' and 59 'species'. De Bruin (1901) also used this classification and gave examples of *Schistosomus reflexus* and *Perosomus elumbis* as simple monsters and *Dicephalus* as a compound monster.

Sloss and Dufty (1980) proposed a more clinical division, placing monsters into one of three major groups and gave a number of examples from each group:-

- a) Malformations characterised by foetal dropsy - including hydrocephalus, ascites and anasarca.
- b) malformations characterised by absence or deficiency of foetal parts - e.g. *Schistosomus reflexus*, foetuses with contorted joints, *Perosomus elumbis*, chondrodystrophic calves and acardiac monsters.
- c) Malformations caused by multiplication of foetal parts - *Diprosopus*, *Dicephalus* and *Craniopagus*.

The incidence of foetal monsters in cattle is higher than in other species (Williams, 1931a). Fleming (1877) suggested that serious malformation might occur in one in 200 calves. In the opinion of the author of this thesis, Fleming's figure was rather high but it is possible that a proportion of foetal monsters are not reported and that careful monitoring of the progeny of A.I. bulls has tended to lessen the incidence of inherited abnormalities. There does not

appear to be any overall difference between the various breeds concerning the incidence of congenital abnormalities (Herschler et al., 1962). There is however considerable variation in the incidence of the different types of foetal monster.

Merrick (1851) suggested that the most frequently encountered bovine foetal monsters might be dropsical, deformed or hydrocephalic whilst Fleming (1877) illustrated numerous grotesque monsters but did not comment upon their relative incidence. In a study of seventeen bovine monsters, Williams (1931b) recorded eight cases of *Perosomus elumbis*, three of *Schistosomus reflexus* but no case of conjoined twins. Roberts (1971) found fourteen examples of *Schistosomus reflexus*, thirteen of *Perosomus horridus*, five of *Perosomus elumbis* and three of conjoined twins among 41 bovine foetal monsters which he had encountered in practice.

Some indication of the relative incidence of the various foetal monsters may be obtained by analysing their occurrence in the literature. This type of survey is open to inaccuracies such as a tendency to report only the more grotesque monsters associated with dystocia. However it is interesting to note that among 154 references to foetal monsters causing dystocia the distribution of the monsters was as indicated below (Table 9).

Table 9. The incidence in the literature of the various types of foetal monster

<u>Type of monster</u>	<u>Nº of references</u>	<u>%</u>
Conjoined twins	51	33.1
<i>Schistosomus reflexus</i>	49	31.8
Bulldog calves	13	8.4
Others*	41	26.6

* Although quite large, this group comprised many different monsters. No category was numerically larger than that of bulldog calves.

Foetal monsters pose problems for the veterinary obstetrician. Great difficulty may be experienced in recognising, by palpation of the structures within reach on vaginal examination, the nature of the abnormality. Williams (1931a) suggested that in the case of conjoined

twins, the point of attachment could mostly be palpated but this is not always the case. Benesch (1938) warned that attempted delivery of a malformed foetus by excess force without at least some partial amputation should never be attempted. In the case of double monsters he felt that if division could not be performed, destruction of the mother might be better than 'aimless attempts at delivery'. Noting the low monetary value and viability of foetal monsters Arthur et al. (1982) advised that once the presence of a foetal monster had been diagnosed, little time should be spent on attempts at vaginal delivery. The obstetrician would be better advised to proceed immediately to caesarean section or embryotomy. Although the incidence of foetal monsters is low both Wilson (1880) and Roberts (1971) wisely warned that they should always be suspected when an apparently simple obstetrical procedure could not be completed in the usual way. Foetal decomposition and maternal loss have been reported in unresolved and neglected cases (Williams, 1884).

Both Hutt (1934) and Leipold and Dennis (1980) called for constant vigilance in the detection and recording of foetal monsters and advised the use of test breeding in cases where there was any suspicion of hereditary abnormalities.

In this thesis foetal monsters will be considered under the headings of (a) Conjoined twins, (b) Schistosomus reflexus, (c) Bulldog calves and (d) Other monsters.

(a) Conjoined Twins

In a review article Arthur (1956b) discussed the veterinary aspects of conjoined twins. He considered that double monsters, conjoined twins and identical twins shared a common origin in that they represented varying degrees of division of the zygote and suggested that conjoined twins might be more common in cattle than in other species. All degrees of separation might be seen from partial duplication of the head to almost total separation into two individuals. Conjoined twins always presented a risk of severe dystocia and in many cases separation of the twins to allow delivery was impracticable.

Arthur (1956b) also considered that acardiac monsters (uterine moles) might be grouped with conjoined twins as they represented an

abnormal and unequal division of the blastocyst. Being normally very small such monsters seldom caused dystocia.

In his article Arthur (1956b) also considered the aetiology of conjoined twins and suggested that hereditary defects, vitamin deficiency, embryonic anoxia, infection or irradiation might all be involved.

Any discussion of dystocia caused by conjoined twins is complicated by the fact that there are so many variations in the degree of separation of the twins. In attempting to discuss the numerous references to conjoined twins in the literature, the author has followed the suggested classification of Gurlt as set out by Fleming (1877).

1. Monsters with a double face - Diprosopus

This monster has been described causing dystocia by Shipley (1877), Harvey (1883), Gardner (1923), Baxter (1930) and Saperstein (1981). In some cases the monster was delivered by traction often with great difficulty. In Saperstein's case the calf was co-twin to a normal calf and delivery by traction was relatively easy. Occasionally such monsters may be born alive although some have cleft palates (Baxter, 1930). Illustrated below (Plate 20) is the head of a Diprosopus foetal monster born by caesarean section at Cambridge Veterinary School. Attempts at delivery by traction had failed as it had proved impossible to bring the excessively wide head into the pelvic inlet. This monster was born dead and had a cleft palate on both sides.

Double-faced monsters may occasionally show signs of other abnormality and one such case was described by Thompson (1911) in which ankylosis of the limbs and spinal cord was present and embryotomy was required to deliver the foetus.

PLATE 20

Foetal monster - Diprosopus - delivered by caesarean section at
Cambridge Veterinary School.

2. Double headed monsters with the trunk wholly or partially
divided - Dicephalus

Examples of this type of monster in anterior presentation have been described by Garner (1851), Hall (1889), Hill (1889), McAleer (1899), Fafin (1907), Thompson (1911), Anon. (1913b), Baxter (1922), Taylor (1922), Barlow (1925), Motton (1925), Taylor (1926), Hughes (1930), Oliver (1934), Tuckey (1939), Wyse (1941) and Irvin (1966). Some cases were delivered by traction, often with tremendous force. In Taylor's (1922) case ten men applied traction with apparently no previous manipulation or embryotomy to deliver the calf and the cow, remarkably, did well. Many cases were complicated by lay interference and Oliver (1934) noted in his case 'the farmer as usual had made a bold attempt to calve her'. Other authors reported long embryotomy operations, Fafin (1907) noted that six hours were

needed using embryotomy to deliver his dicephalic monster. In other hopeless cases the cow was destroyed (Anon., 1913b).

A particularly difficult problem may be encountered when dicephalic monsters are found in posterior presentation at the pelvic inlet. Here the foetal hindquarters may appear normal but traction fails to effect delivery. Such cases have been described by Carlisle (1840), Winter (1896), McTurk (1911), McDowell (1922), Barlow (1925), Hogben (1928), Ver (1929) and Miles (1933). Once again accounts occur of massive force being applied to deliver these monsters. On arrival at his case Barlow (1925) found that the rear end of the calf had been completely pulled off. Winter (1896) found his patient in an extremely exhausted condition and having given her one pint of whisky, delivered the calf by embryotomy and traction. The cow made a good recovery. Undoubtedly many of these cases could have been far more satisfactorily dealt with by caesarean section.

3. Monsters with single head but with the trunk and limbs more or less double - Dipygus

Three cases of this type of monster have been recorded in the literature. Cartwright (1836) described a case in which the calf was delivered by traction by an unqualified farrier aided by fifteen men. The cow died having suffered a uterine prolapse on the following day. Beckett (1926) encountered a case in a heifer which he successfully delivered using embryotomy and traction. In a case involving a ten-year-old recumbent cow Bowen (1966) attempted traction without success on a suspected double monster. The cow was slaughtered in view of her poor general condition and dissimilar male conjoined twins were found in utero.

4. Monsters with the head and limbs more or less completely double - Somatodidymi

This group of foetal monsters includes those commonly known as 'Siamese twins'. There have been a number of accounts of such bovine monsters all of which have caused severe obstetrical difficulty. Meginnis (1851) attempted unsuccessfully to deliver his case by

embryotomy and his patient was slaughtered, as was that of Hoare (1893a). In the latter case a large conjoined double monster was found at slaughter with the fetuses joined at the sternum and abdomen, facing each other 'as if in embrace'. Dawson (1903b) was able to deliver a pair of Siamese twins but seven hours of embryotomy were required. Green (1912) having failed to deliver a similar monster noted ominously that as he gave up 'a butcher stepped forward from the crowd his pole-axe at the ready'. Other cases were recorded by Conchie (1914), Cattell (1932) and Krueger (1954) and only that of Krueger was delivered and this by embryotomy. Caesarean section to deliver Siamese twins was successfully performed by Berry (1959) and is undoubtedly the best course of action although embryotomy via the laparotomy wound may be required before the monster can be removed from the uterus.

Another 'genus' within the 'order' Somatodidymi is Pygodidymus where the conjoined twins are united at the croup. In one case (Anon., 1928) what appeared to be a normal calf was palpated in anterior presentation but with lateral deviation of the head. The malposture was corrected with ease but traction failed to deliver the calf and at slaughter the monster was discovered. A somewhat similar monster was described by Auld (1940). In this case delivery was achieved by embryotomy, good lubrication and traction.

5. Monsters with a single head and trunk but with more than four limbs - Melodidymi

A single case of dystocia caused by a monster of this 'order' has been encountered in the literature. Delivery of the monster, recorded by Gupta (1912) was achieved by cautious traction. A pair of accessory hind limbs was found to be growing from the dorsal aspect of the calf's lumbar region and according to Gurlt it would belong to the 'genus' Opisthomelophorus.

(b) Schistosomus reflexus

Classified by Gurlt as a simple monster with abnormal division of the body, this rather grotesque monster has been the subject of much comment in the literature. It has also been described as a

celosomian monster and in some areas as a 'moon calf' (Penhale, 1906). The spinal column of the monster has undergone dorsi-flexion to such an extent that the head and tail of the foetus are closely approximated. The limbs are often ankylosed and deformed and the abdominal and thoracic cavities are open. Occasionally the head and limbs are enclosed in a membrane which may be the remnants of the displaced body wall (Olver, 1919; Williams, 1931b; and Harmar, 1943). A closely related group of monsters are those in the 'genus' *Schistocormus* and some confusion may be seen in the literature when cases regarded as being similar were not in fact so. Drabble (1895) and Thompson (1896) described dystocia cases in which the foetal abdomen only was open - examples of *Schistocormus fissiventralis*. Wilson (1880) recorded a case of what appeared to be *Schistosomus reflexus* but which was, when examined by Fleming, found to be a case of *Schistocormus fissiventralis* and *fissisternalis*. These problems of exact classification are of little importance to the obstetrician since despite minor anatomical differences the monsters present similar problems during delivery.

Schistosomus reflexus is one of the most common foetal monsters in cattle. Simpson (1899) noted that it was 'frequently met with in practice' and Williams (1931b), Roberts (1971) and Sloss and Dufty (1980) are among authors who have listed it as the most frequently occurring foetal monster. Contemplating the possible cause of the monster Simpson (1899) observed 'the owner attributed the cause of the malformation to the fact that a pack of drag hounds had been in the habit of crossing the field frequently and this particular cow was always much excited and galloped after them some distance'. Simpson apparently supported his client's views when he added 'this I think is a very feasible solution'.

At one time Williams (1931a) considered that *Schistosomus reflexus* might arise as a result of abnormal adhesions between the foetal allantois and amnion with consequent tension being applied to the foetal abdominal floor. Later he stated that he now considered the problem to be hereditary and postulated that the abnormality arose when the edges of the germinal disc of the embryo were reflected dorsally instead of ventrally (Williams, 1943). Evidence supporting the hereditary nature of the condition has come from Edwards (1941)

who reported four cases of *Schistosomus reflexus* among eight calves sired by a young Shorthorn bull. Similar evidence was provided by Keatinge (1941), Margaron (1941) and Turnbull (1941). Hogger (1965) reported the case of a cow which produced the monster at her second and third parturitions both the result of mating by the same bull.

One of the earliest reports of dystocia caused by *Schistosomus reflexus* was that of Cartwright (1829). Many other reports followed and it is clear that not all the authors were aware of previous accounts. Watson (1871) proudly described his monster as a 'possible new discovery' despite the fact that many previous accounts had appeared in the veterinary press. Following yet another account of the monster (Bramall, 1918) the editor of the *Veterinary Record* commented 'enough is already known of the gross anatomical abnormalities that may interfere with delivery and perhaps more than enough has been published'. Occasional reports have recorded other foetal abnormalities co-existing with *Schistosomus reflexus* including hydrocephalus (Watson, 1871) and hydrops amnion (Sloss and Dufty, 1980). Although cases of unaided delivery of this monster have been recorded (Goule, 1880) in most instances dystocia occurs. The gross deformity of the monster prevents easy passage through the birth canal. The ankylosed limbs and the unprotected ribs of the monster predispose to laceration of the uterus or vagina during delivery.

The monster may present either its head and extremities or its viscera at the pelvic inlet and from those references where presentation is described it appears that of presentation of the head and extremities is the more frequently encountered. The reason for this may be either that the wedge-shaped head-and-extremities face of the monster will tend more easily to enter the pelvic inlet or that, as this presentation is more difficult to deal with, it is more likely to be reported in the literature. Head-and-extremity presentations associated with dystocia have been described by Cartwright (1829), Sarginson (1859), Marshall (1867), Wilson (1867), Watson (1871), Arkoll (1880), Lawson (1891), Winter (1896), Kay (1897), Maynard (1898), Simpson (1899), Moffett (1902), Wilson (1910), Caudwell (1912), Olver (1919), Carbury (1924a), Walker (1926), Alexander (1929) and Wheat (1948). Visceral presentations have been

described by Toll (1860), Wilson (1867), Goule (1880), Merrick (1889), Lomas (1896a and b), Hutton (1898), O'Dea (1914), Roberts (1919), Baxter (1920), McDowell (1922) and Smythe (1941).

In the case of head-and-extremity presentation, the obstetrician may easily confuse the monster with the simultaneous presentation of twins (Roberts, 1971). In a graphic description of the problem Wilson (1910) noted the severe difficulties which might be encountered. Lack of room was a major problem and the textbook formula 'reduce the size by embryotomy' was difficult to follow.

The appearance at the vulva of intestine, which is often the first sign of the visceral presentation of the monster, may cause great alarm to the stockman who suspects that the viscera may be those of the dam. Further examination may reveal the presence of other foetal viscera including the liver and if the monster is alive the foetal heart beat may also be felt. Foetal intestines at the vulva are not necessarily those of a Schistosomal or Schistocornal monster and Tutt (1943b) described a foetus with an umbilical defect through which the intestines were protruding.

The difficulties experienced by the veterinary obstetrician in dealing with *Schistosomus reflexus* are made greater when lay interference has complicated the delivery. Marshall (1867) noted that before he attended his case 'three shepherds had spent twelve hours trying to deliver her'. His attempts at delivery were unsuccessful and the weakened animal was destroyed. To the laymen the monster can be an amazing sight and Baxter (1922) graphically described the reaction to one such case. 'The cowman, cow and her owner were gazing open mouthed at the results of her labours and the cowman actually suggested that the bull be brought round to see what he thought about it'.

Occasionally *Schistosomus reflexus* monsters have been seen as co-twins to normal calves and their smaller size compared with a singleton monster has enabled them to be delivered with little difficulty (Anon., 1834; Merrick, 1889; Bennett, 1915 and Harmar 1943).

Whenever possible a careful and logical approach to the delivery of Schistosomal monsters should be adopted. Barrell (1850) warned that 'great perseverance' was often necessary and Hally (1912)

observed that 'several hours of embryotomy' might be required. Greenough (1952) proposed the following routine approach to the case:-

1. If head and extremities presented - apply traction to all four limbs.
2. Bisection of the body should be attempted if in visceral presentation.
3. Normal embryotomy - unlikely to be successful in head and extremity presentations - limbs should be removed by torsion and traction.
4. Following hind limb removal traction might be applied to the head and fore limbs.

It is interesting to note that Greenough (1952) did not list caesarean section in his plan of treatment. Caesarean section had previously been used to deliver *Schistosomus reflexus* by Carbury (1924a) and Smythe (1941) and the latter noted that a large uterine incision was required to remove the monster from the uterus.

In most cases of visceral presentation delivery may be possible by applying traction to the monster following manual removal of the viscera. Traction may be applied using Krey's hooks and Wilson (1867) used a long hook inserted into the 'hole in the bony mass through which the oesophagus may be traced'. Rather surprisingly Lomas (1896a and b) described how he successfully converted a visceral presentation into a head and extremity presentation which he then delivered by traction. Despite suffering a ruptured uterus, the cow made a good recovery.

Head-and-extremities presentations are generally regarded as being more difficult to deal with than visceral presentations. Occasionally traction alone may be successful but embryotomy may be attempted. Piece-meal removal of such parts of the monster as are accessible may be the only way of proceeding and despite care damage or infection may result (Steele and Simms, 1956). Arthur et al. (1982) have suggested that vaginal delivery is seldom worth attempting and that the best course of action might be to proceed immediately to caesarean section.

(c) The Bulldog Calf

One of the earliest descriptions of dystocia caused by a bulldog calf was that of Hoare (1893b) who encountered a case in a cow calving after eight months gestation. On vaginal examination he found 'a very large head in the passage'. At first he thought the foetus had no legs but eventually he found that they were 'like a dog's but with bovine feet'. He delivered the calf by traction after 'a good deal of trouble'. He further described the foetus as having a 'head large and like a bulldog'. Both fore and hind legs were short and the abdominal cavity was enormous when compared to the legs which were of insufficient length to raise the body from the ground. Cameron (1896) described four cases in Kerry cows and noted that the hind limbs of the calf 'appeared to grow out from the back'. De Bruin (1901) also described this type of monster but referred to it as an 'otter calf'. The monster could possibly be placed in the 'genus' *Nanomelus* of Gurlt's classification although it was not specifically described (Fleming, 1877).

A series of bulldog calves in the Dexter breed was described by Begg (1903) and his account brought further reports involving this breed from Dawson (1903a) and McLaren (1903). In most cases the bulldog calf was stillborn but Waghorne (1910) and Baxter (1922) both described cases in which the monster survived for one hour. Several cases of bulldog calves among Kerry cattle were reported by Pack (1921); all were the progeny of one bull and when he was replaced no further trouble occurred.

Crew (1924) regarded the bulldog calf as a 'contribution to the study of achondroplasia' and differentiated the bulldog calves of the Dexter breed from those of other breeds. In pure bred Dexters the incidence of bulldog calves was one in 5.5 and the affected foetus could be expelled unaided with little consequence to the dam. In other breeds dystocia might be severe, chiefly as a result of failure of the birth canal to accommodate the foetal head. The bulldog calf might also be anasarctous, a factor which further complicated delivery. Hutt (1934) considered bulldog calves to be an example of inherited lethal characteristics and that one in four calves born to pure bred Dexters might be affected.

Bulldog calves have also been reported in Friesian cattle and Berger and Innes (1948) recorded four cases among 22 calves sired by one bull. In one animal the bulldog calf was co-twin to a normal calf. Four grades of achondroplasia in cattle were described by Gilmore (1949). He considered the bulldog calf to be the most severe type, whilst the least severe was seen in Norwegian Telemark cattle. In this latter form the foetus was frequently born alive but did not survive for long.

Further studies in Dexter herds were reported by Young (1951) who considered bulldog calves were produced by a single dominant autosomal gene. Jones (1961) agreed with this view but reported a problem involving bulldog calves in Guernsey cattle caused by a lethal recessive gene. Two carrier bulls were imported to the island of Guernsey to 'improve' the local breed. Fifteen calves showing bulldog characteristics were found among 502 progeny of the two bulls. Dystocia was reported in 40 per cent of the cases of bulldog foetuses. Sloss and Dufty (1980) noted that bulldog calves had also been seen in Aberdeen Angus and Hereford cattle.

In most cases bulldog calves may be delivered by traction following careful lubrication of the birth canal. Not only may the calves be anasarcaous (Wilson, 1881; Crew, 1924) but they may also be ascitic (Arthur, 1966) and delivery is often complicated by a failure of the birth canal to dilate (Crew, 1924; Sloss and Dufty, 1980). Roberts (1971) suggested that traction might be applied to the bulldog foetus by means of an obstetrical chain encircling the foetal girth.

(d) Other Foetal Monsters and Abnormalities

(i) Abdominal Enlargement

One of the most important causes of dystocia caused by enlargement of the foetal abdomen is ascites. Simonds (1849) illustrated a case of this type of dystocia in which the foetal abdomen was being drained by a long trocar passed down through the chest. Cox (1877a and b) and Gray (1877), describing similar cases, both agreed that Simonds' trocar (copied from Skellett's illustration) would be quite impractical and preferred to drain the abdomen through a knife

wound. Lehr (1934) recorded a case of foetal ascites in posterior presentation in which delivery was further impeded by a massive fluid-filled scrotal sac. Following drainage of 3-4 gallons of fluid from this sac, the foetus was delivered by traction.

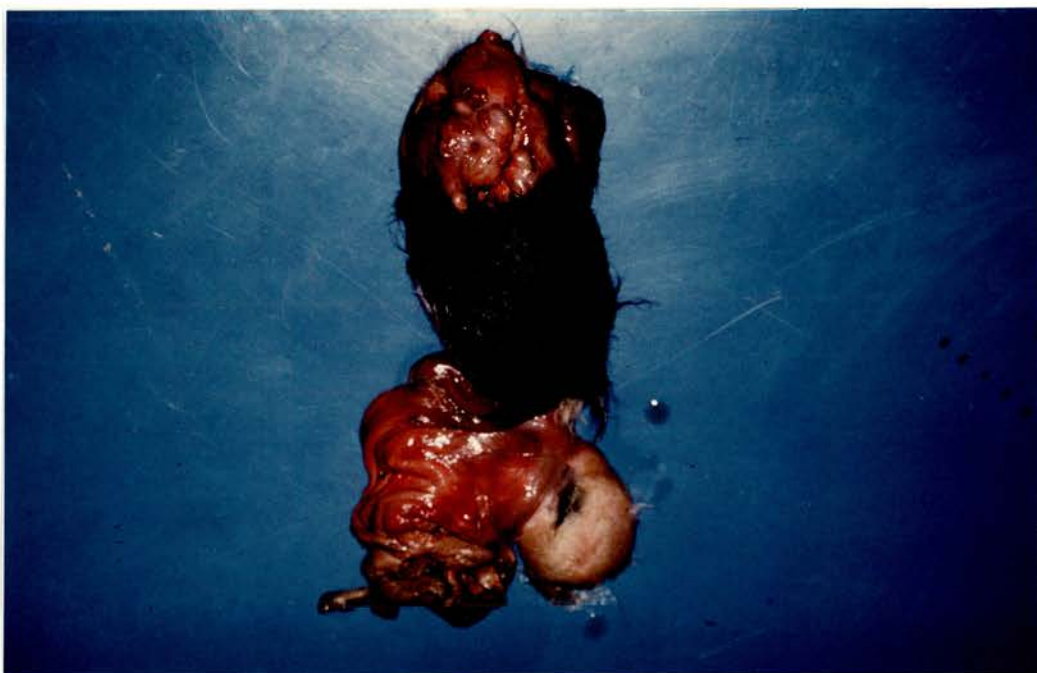
Other causes of foetal abdominal enlargement have also been recorded. Cowie (1964) found a large intra-abdominal fibrosarcoma weighing 32 pounds and 16 inches wide at its greatest diameter which prevented the delivery of a calf. A massive intra-abdominal fibrochondrolipoma was found following caesarean section by Donnelly et al. (1975).

(ii) Acardic monsters

These small objects regarded as ectodermal remnants of a partially divided zygote (Arthur, 1956b) are seldom in any way involved in dystocia. They are often passed unnoticed in the placenta and are rarely reported in the literature (Gamgee, 1855; Baxter, 1927; Broad, 1927; Edgar, 1927; Hagan, 1928 and Young, 1952) Catterall (1955) found an acephalic monster among five foetuses in the uterus of a cow which died of poverty during her fifth pregnancy.

In an interesting case which was believed to be a possible dystocia (Pilsworth, personal communication) the foetal acardiac monster illustrated below (Plate 21) was seen at the vulva of a cow two days after she had delivered a normal calf. It was believed to be the foot of a second retained calf and its identity was not discovered until veterinary attention was sought. The monster was approximately six inches in length.

PLATE 21



Acardiac Foetal Monster - mistaken for the foot of a retained foetus

(iii) Amputate

Bishop and Cembrowicz (1964) described a case of amputate in which a calf was born with all four limbs deficient in their lower parts. Although this monster was born without difficulty the authors considered that problems might have arisen as a result of the greatly distorted head which accompanied the limb deformities.

(iv) Anasarca

Foetal anasarca - gross generalised oedema - can cause great problems to the obstetrician. Pafin (1903) described a case in a cow in which traction by five men failed to deliver the monster. Cysts of anasarca tissue were punctured, the foetal abdomen was drained and the calf delivered after five hours. Surprisingly the cow survived. A similar case was described by Robson (1906). Donald et al. (1952) studied data on 325 anasarca calves in 60 Ayrshire herds and concluded that the problem was caused by a single autosomal recessive gene. The condition caused great concern among breeders, numerous cases required embryotomy and the maternal mortality was high. A single case in an Ayrshire cow was reported by Johnson and Haxby (1955). Delivery of the calf per vaginam proved impossible despite drainage of much fluid. The calf which weighed 214 lbs was finally delivered by caesarean section.

(v) Ankylosis

Ankylosis of the foetal joints can give rise to severe dystocia. The abnormal position of the ankylosed limbs may cause unavoidable malpresentation and attempts at correction may result in laceration of the birth canal. Stinson (1930a) who practised in the North of England reported a number of deformed calves all sired by the same bull. Although he gave no details, Stinson noted that 'serious surgical intervention' was required to deliver the calves. Uterine rupture, peritonitis and death of the mother were the consequences of attempts made unsuccessfully to deliver a calf with rachitic ankylosed joints (Heijbel, 1932).

Morrow (1938) reported three cases of ankylosed fetuses in crossbred heifers sired by different bulls. Embryotomy was required in two cases to deliver the calves. An outbreak of generalised foetal ankylosis was reported in New Zealand by Currie (1951) and by Murray (1951) which involved Friesian cattle in four herds. The

cause of the deformity was believed to be an autosomal recessive gene traceable to one bull. All foetal joints were ankylosed and the fetlock joints in the forelimbs were 'reversed', with the digits flexed anteriorly. So common was the problem that Murray (1951) described his routine approach to dystocia caused by the monsters. Anteriorly presented fetuses caused the greatest problem as their hind limbs became trapped beneath the uterine fold and embryotomy was routinely employed to deal with them. Posterior presentations were delivered by careful traction.

(vi) Arthrogryposis

This problem was first reported in Australia by Blood (1956) and by Judge (1956) and affected calves suffered grossly distorted limbs caused by abnormal tendon contraction which in turn prevented normal joint movement. Blood (1956) found that in most cases the calves were smaller than normal and might be delivered by careful manipulation and traction. In some calves evidence of hydrancephaly was seen and Blood (1956) proposed a common cause for both abnormalities. Arthrogryposis might be caused by abnormal innervation to the foetal limbs. Hartley and Wanner (1974) reported 62 cases of arthrogryposis and hydrancephaly which occurred between 1964 and 1973. No obstetrical details were given but caesarean section or embryotomy were required to deliver some cases. The limb deformities involved all four limbs or the forelimbs alone. Further studies (Hartley et al., 1975) reported antibodies to Akabane virus in the serum of cows which had produced abnormal calves and later antibodies were found in the pre-colostrum serum of affected calves (Hartley et al., 1977). It is interesting to note that Edwards (1976) was able to produce the defect in sheep fetuses by exposing the ewe to heat stress during pregnancy. Logue et al. (1977) reported two cases of arthrogryposis with palatoschisis in two closely related Charolais calves. They believed the problem to be caused by an autosomal recessive gene and that the 1/29 gene translocation they observed might be a coincidental finding.

(vii) Hydrocephalus

One of the earliest references to bovine hydrocephalus as a cause of dystocia was that of Maw (1860) but his description was somewhat confused and the monster may have been a bulldog calf. An

unusual case of dystocia was described by MacGillivray (1877) who encountered a cow in which a hydrocephalic calf presented posteriorly. The foetus was delivered by traction using five men and a massive enlargement of the cranium was considered the cause of dystocia. Baxter (1922) reported the successful delivery of a hydrocephalic calf following evacuation of the cranial swelling by trocar and cannula. Prolonged gestation may further complicate the delivery of hydrocephalic calves if the anterior pituitary gland is compromised by cranial pressure (Mutiga et al., 1981).

(viii) Perosomus elumbis

This monster which was encountered in the surveys of Williams (1931a) and of Roberts (1971), has a relatively normal front end of the body. The lumbar vertebrae and spinal cord are rudimentary and the hind limbs are contorted and ankylosed possibly as a result of lack of movement in the developing foetus. In anterior presentation the monster may be mistaken for a normal calf but attempts at delivery by traction may be confounded by the rigid hind parts. In posterior presentation the monster may be more easily recognised but delivery may also be difficult. Cartwright (1843) described a case of *Perosomus elumbis* with hind limbs in an ankylosed breech presentation. He attempted unsuccessfully to correct the breech and eventually had to break the hind limbs in order to remove them. Finally the calf was delivered by traction, but the cow died and a lacerated uterus was discovered at post mortem. Later Cartwright (1847b) described another case of *Perosomus elumbis* but which on careful scrutiny was apparently the same case referred to in his earlier paper. Another case, also in breech presentation was described by Younghusband (1854b) who managed to turn the calf in utero and deliver it by 'unmerciful traction'. Miraculously the cow survived. Metherell (1883) and Fincher (1931) reported similar cases in breech presentation both of which were successfully delivered using embryotomy.

(ix) Pituitary hypoplasia or aplasia

Huston and Gier (1958) described the delivery of a calf which weighed 138 lbs and whose period of gestation was 346 days. The head was somewhat misshapen and at post mortem pituitary hypoplasia was detected. Irvin (1966) reported the case of a calf delivered after

589 days gestation following 'two hours' strenuous pulling'. The head was grossly abnormal and no brain or pituitary gland were found. Betteridge (1966), commenting on this case, prophetically noted the relationship between prolonged gestation and pituitary aplasia.

(x) Miscellaneous Monsters

Perhaps the most extraordinary monster in this group was that described by Anon. (1828) which was apparently delivered by traction. The monster had some human features. Its face was 'smooth and without hair, the eyes were blue and the eyebrows yellowish brown and on its chest were two hemispherical breasts with prominent nipples'. A cyclops-like monster delivered by Wilson (1868) may well have been complicated by pituitary aplasia as it was born following 55 months gestation. A massive chest wall tumour, believed to be of thymic origin was described causing dystocia by Anon.(1907) and was delivered by embryotomy.

CHAPTER THIRTEEN

THE APPROACH TO A CASE OF BOVINE DYSTOCIA

The availability of the motor car and of modern communication networks has enabled rapid contact to be made with the veterinary surgeon when his attendance is required at a case of bovine dystocia. In earlier times, veterinary aid was sought either on foot, on horseback, or by bicycle. The veterinary surgeon in turn had to rely on similar modes of transport to attend his cases. As the messenger despatched to call the veterinary surgeon was not always of high intelligence and writing was not a universal attribute, problems of communication were frequently encountered. Richardson (1901) advised that the messenger should be 'interrogated' to establish as many details of the case as possible before the veterinarian set off to deal with it.

The importance of obstetrical work and its competent handling has already been discussed and was summarised by Tutt (1944) who wrote 'it should be recognised that treating bovine dystocia is not a simple procedure but requires anatomical knowledge, skill and physical exertion. Care and skill shown by the veterinary surgeon will elevate the position and status of his profession in the eye of the public more than any degree or special diploma and the reverse is also true'.

Fortunately in modern times good communications, the value of the dam and foetus and the appreciation of veterinary obstetrical skill have eliminated many of the gross inhumanities of lay interference. This has not always been the case and the comments of Armatage (1860) were undoubtedly pertinent. He said 'I generally find that the animal has been brutally handled and often tampered with for some hours before I am summoned by persons of very doubtful judgement and discretion in these matters'. Taylor (1903) regarded lay interference as 'a major problem' and Williams (1943) warned that the veterinarian should be on constant guard for evidence of it. Cox (1875), probably speaking from bitter experience, believed that should it be necessary to leave a case to obtain additional equipment the animal should be protected from lay interference during his absence. He wrote 'Experience taught me this essential precaution; I had the animal locked up until my return and made one man responsible for her safe custody'. Such

preventive measures might, with advantage, have been taken by Cross (1887) who left a case in which cervical dilation was incomplete in order to fetch instruments with which to perform vaginal hysterotomy. On his return he found that the owner had pulled the calf and the uterus from the unfortunate cow which had died from its injuries. Fortunately lay interference is not always of such a violent nature and Weipers (1926) reported a case in which the owners had attempted to deliver a foetus in breech presentation by ineffectually pulling upon its tail. As Straiton (1960) observed, the 'idea that the calf must be brought into the world at all costs, irrespective of the methods used and of the damage inflicted' was a generally accepted view by both layman and veterinarian until relatively recent times.

Examples of the excessive and unnecessary use of force during foetal delivery are frequently encountered in the literature. MacGillivray (1883) was called to a dystocia case in which traction by five men had failed to deliver a foetus in posterior presentation. It was not until traction by ten men had also failed to move the foetus that MacGillivray discovered that foetal ascites was present and was the cause of dystocia. Drainage of the foetal abdomen was followed by an easy delivery.

Early arrival at the case of bovine dystocia is essential and as Rowlands (1812) observed 'prompt attention should be given to problem cases since early cases are more easily dealt with'. Fleming (1877) considered 'the veterinarian should lose no time in giving a service as every minute's delay may render the case more difficult and tend to compromise the life, not only of the young, but also of the mother'. Premature interference can also cause problems and undue haste especially in attempting to extract the calf may cause serious losses (Straiton, 1957). Each case must be considered on its merits and as Edwards and Jones (1957) noted, time could be 'the staunchest ally or a bitter enemy' depending on the circumstances.

The author firmly believes that when called to a case of suspected bovine dystocia early attendance, but not necessarily interference, is essential. The reliability of one's clients must be taken into account but there can be no substitute for personal examination and appraisal of a case whether or not immediate action is taken. Much sensible advice can be given to assist the farmer in determining when to seek

professional help. Straiton (1957) advised that if, after several hours of straining, nothing was showing at the vulva it was permissible for the farmer to wash his arm thoroughly and examine the cow per vaginam to determine the disposition of the foetus. Should the latter be wrong, the veterinary surgeon was to be called. If the foetal disposition was correct the cow should be left until she calved naturally. In Straiton's view the majority of cows would calve unaided within 12-36 hours although he had left animals up to three days before assisting them to deliver living calves. He later admitted (Straiton, 1960) that using his conservative approach calf mortality might rise (up to 90 per cent after 40 hours) but that the cow was quite undamaged. He also clarified his advice to clients stating that if no progress had been made in cases where the presentation was normal after twelve hours then veterinary help should be called to see the case again. As has already been mentioned, Straiton's views, expressed publicly on both radio and television were regarded by many as unsafe and claims were made of unnecessary lossess occurring as a result of his advice being adopted. Much support was given to his views that premature interference in cases of dystocia and hasty extraction of the foetus were contra-indicated but White (1957) emphasised the need for common sense also to be employed in each case. Others felt that Straiton had been too dogmatic in presenting his individual views in such a public arena. Some authors were less complimentary and Rainey (1957) observed 'I should like to set Mr. Straiton down with his half pound of lard and three feet of cord behind an 18-month old Jersey heifer with an impacted oversize foetus twenty miles from the nearest Tasmanian farmhouse in the shelter of a wire fence on a winter's night and watch his work'.

The place of calving

In many cases, especially when the cow is recumbent, no choice of calving place is available and the clinician must proceed wherever he finds his patient. Benesch (1938) advised that when possible the calving quarters should be well lighted and Straiton (1957) recommended the use of a loose box with the floor sprinkled, under the bedding with grit or sand to enable both the patient and her helpers to maintain a good foothold. Specialised hospital facilities are seldom available

but Williams (1943) recommended that when trucking and hospital facilities were available, full use should be made of them.

Johnston and Sloss (1967) strongly advised the provision of special crush facilities as did Blackmer (1980) and Schuijt and Ball (1980). The latter authors proposed a maternity room 18 ft. square to allow adequate room to work behind the restrained cow. The room should be well lighted, warm and easy to clean and disinfect. The cow should be secured by a sturdy stanchion and head gate with choke-free uprights. Sturdy swinging wings were attached to the head gate and could be closed (thus acting as a crush) or fully opened when the cow was recumbent. They recommended that straw bedding should be provided and should be changed after each cow. Polythene sheets might be laid behind the cow to avoid excessive contamination of the bedding at the time of calving. Unfortunately, such specialised calving accommodation is seldom available but if the cow is in an unsuitable position and especially if insufficient room is available to work behind her the author firmly believes that every effort should be made to move her to a more suitable place.

Restraint and Anaesthesia

Although Fleming (1877) observed 'the pains of labour usually render the most vicious animal tractable' some form of restraint is essential before obstetrical assistance can be rendered. Sloss and Dufty (1980) noted that parturient animals normally attempted to resist excessive restraint and therefore they advised that the latter should be kept to a minimum. Johnston and Sloss (1967) found that less than 10 per cent of beef cows could be restrained without difficulty and stressed the need for adequate handling facilities. Forceful restraint, often requiring the animal to be caught by lasso was they considered severely stressful. They recorded two maternal deaths among 635 cases of dystocia caused by injury, including vertebral fracture, sustained during catching. The author encountered similar problems in dealing with yarded beef cattle in the Isle of Ely. Once obstetrical manipulation commenced, however, Johnston and Sloss (1967) found that their patients became somewhat more tractable.

Jackson (1963) recommended that the animal should have her head secured by a halter and never by a lasso loop and that efforts should

be made to prevent her hind end from swinging about during examination. Xylazine sedation had proved a valuable asset in the handling of intractable parturient animals. Rosenberger (1979) warned that xylazine might increase the strength of uterine contractions and advised that if necessary isoxsuprine should be administered at the same time to counteract this effect. The administration of xylazine may cause the animal to become recumbent and as Benesch (1938) observed, recumbency might increase the difficulty of examination and treatment. The same author recommended the use of chloralhydrate for sedation and anaesthesia of difficult cases but Sloss and Dufty (1980) warned of the danger of regurgitation of ruminal contents when heavy sedation was used in bovine animals. Another author (Anon., 1919b) having successfully used chloroform for canine anaesthesia noted that he now used it for all difficult cases of dystocia in the cow. He also (perhaps unwisely) suggested that larger doses might be safely used for obstetrical work than were normally used for surgical work.

The technique of epidural anaesthesia introduced into veterinary obstetrical work by Benesch in 1926 (Brook, 1930) was quickly adopted in many countries including Britain (Turner, 1927), Germany (Götze, 1929a, b), Scandinavia (Sandstrom, 1929) and France (Dauvois, 1932a). The technique is a simple one. Under conditions of strict asepsis 7-10 ml of a two per cent ~~solution~~ of local anaesthetic are deposited in the epidural space by means of a needle inserted into the space between the spines of the first and second coccygeal vertebrae (Arthur et al., 1982). The result of the injection - a multiple spinal nerve block - is to produce anaesthesia in the anal, perineal, vulval and vaginal regions with resultant loss of pelvic sensation and the reduction or abolition of abdominal straining. Benesch (1938) listed the advantages of the technique of which the first was the abolition of pain, an important humanitarian consideration. The abolition of abdominal straining suspended defaecation allowing obstetrical work to be performed in cleaner conditions and also prevented the immediate expulsion of infused lubricants from the uterus. Although epidural anaesthesia did not abolish uterine contractions, intra-uterine pressure was greatly reduced as a result of the suppression of abdominal straining. This allowed manipulation of the foetus, including repulsion, to be performed with greater ease within the uterus. Following the administration

of epidural anaesthesia abdominal straining is no longer available to assist with foetal expulsion but as Arthur et al. (1982) observed uterine contractions which they described as 'the main force of labour' were not antagonised.

Instruments and equipment

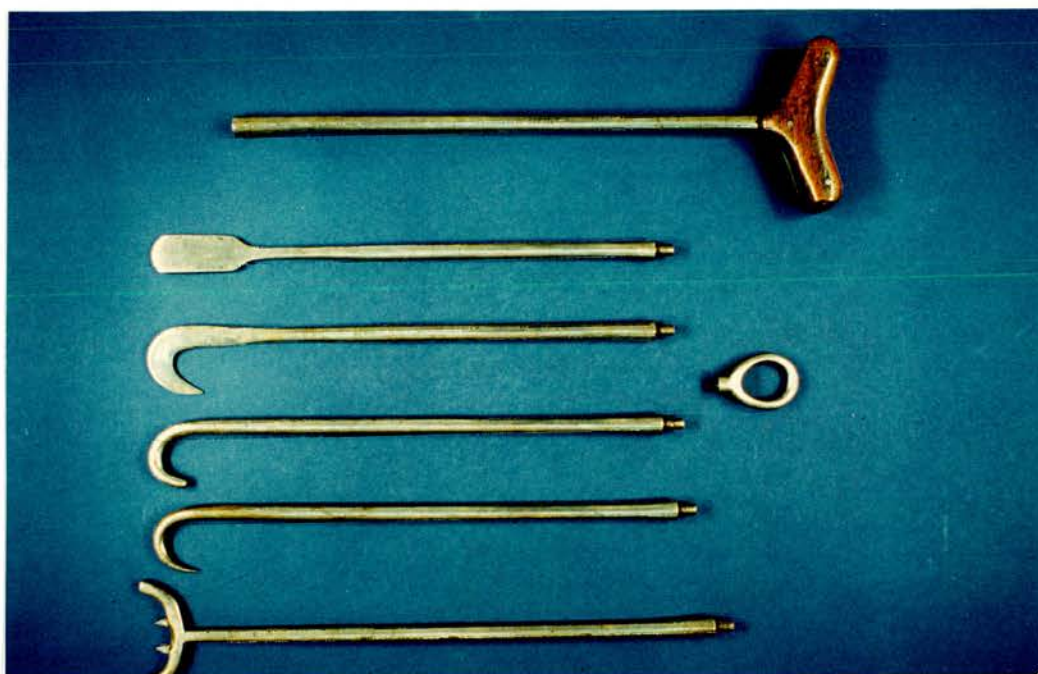
The instruments available for use when attending a case of bovine dystocia vary greatly from practice to practice. In old established practices with a considerable bovine obstetrical workload, elaborate sets of instruments may be available (Tutt, 1944). Other practices may possess only the most basic equipment such as a set of calving ropes. Comparison of modern instrument catalogues with those published 30 years ago has revealed the great reduction which has taken place in the number and diversity of bovine obstetrical instruments which are now available. Some modern catalogues show only calving ropes or chains for traction, a calf puller and Thygesen's embryotome. The high cost of instrument making, the relatively low demand for instruments and the greater popularity of bovine caesarean section have undoubtedly contributed to these changes.

Gangee (1860) commented on the current (19th century) paucity of good obstetrical instruments noting 'When I first came to Scotland the obstetrical instruments amounted to only three or four and two of that number were little better than useless'. He claimed to have collected a good supply of instruments from Europe where 'the science and art of obstetrics were much further advanced'. Gray (1877) made a plea for better quality instruments whilst Horsburgh (1846b) was somewhat sceptical of those that were available. He noted 'any piece of iron or instrument may look well enough on paper or sound well enough before students but can be dangerous in inexperienced hands'. Maynard (1898) also was sceptical when looking at Pollock's (1898) 'array of machinery'. He said 'I would like to see any advance but I'm afraid that if I have to buy all these fresh instruments my fees won't pay for them'. Somewhat similar views were expressed later by both Edwards (1902) and Baker (1926).

A number of complex sets of instruments were available, including 'Fletcher's instruments', date unknown, illustrated below (Plate 22). The set comprised a handle and a metal ring which might be attached to

a repeller, a chisel/spatula and blunt, sharp or cutting hooks. Edwards (1902) expressed disquiet with devices which were attached at screw joints believing that they might become unattached in utero although Gowing (1849) had reported success with this type of multi-headed instrument.

PLATE 22



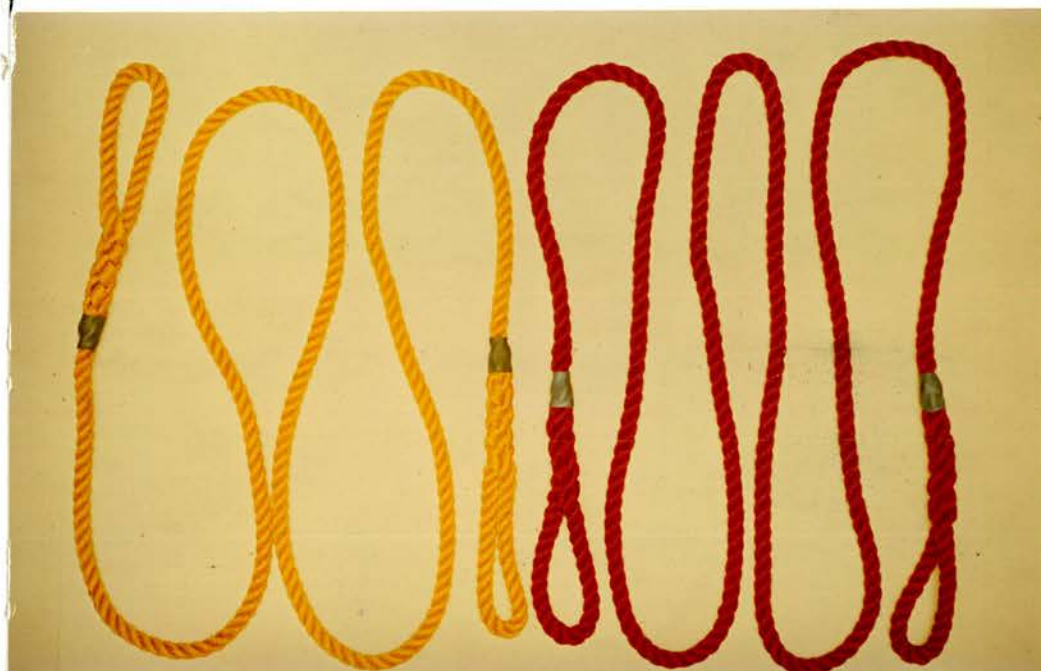
Fletcher's obstetrical instruments

Instrument manufacturers were at one time happy to produce sets of obstetrical instruments to order and Walker (1886) described his own set which he had patented and which had been produced for him by Messrs. C.J. Hewlett. The instruments consisted of a pair of self-tightening forceps, a long and short jointed hook, a crutch and also an embryotomy knife. The majority of veterinary obstetrical textbooks have illustrations of the various instruments which were available at the time of their publication (Fleming, 1877; de Bruin, 1901; Benesch, 1938; Roberts, 1971; Sloss and Dufty, 1980).

Baker (1926) advised that the veterinarian should have a car with plenty of boot space to carry his equipment whilst Kingman (1955) who had worked as a veterinarian at the Wyoming Hereford Ranch in Cheyenne

found it helpful in the absence of a clean water supply to carry washing equipment in addition to obstetrical ropes and chains. Both Broad (1873) and Williams (1943) advised that obstetrical instruments should always be kept in a clean state and ready for immediate use. Benesch (1938) urged that whatever instruments were purchased they should always be of good quality. Other authors preferred to use home-made equipment. Lang (1924) described the use of 'disposable calving ropes' each made out of three strands of binder twine which he threw away after one period of use. The author of this thesis found that he could deal with most calving cases encountered in practice using only two or three nylon calving ropes of a type illustrated below (Plate 23) to apply traction.

PLATE 23



Nylon calving ropes - the use of ropes of differing colours may be found useful when giving instructions to assistants during assisted foetal delivery.

Alternatively Moore's obstetrical chains and handles illustrated below (Plate 24) may be used. Williams (1943) believed chains to be a 'recent idea' and considered that they had some advantages especially

that of ease of cleaning. Ryan (1930) advocated 'ropes' of copper wire noting that they were easily attached to the calf's limbs. The risk of tissue damage must have been considerable.

PLATE 24



Moore's obstetrical chains with handles - the chains are available in a number of lengths but the author has found the shorter chains most useful in practice. The handles are designed to engage the chains at any point along their length.

Eyehooks may also be included in the obstetrical kit. Their use (illustrated by Benesch, 1938) is chiefly to apply traction where there is insufficient room to apply a calving rope around the foetal head. Illustrated below (Plate 25) the eyehooks will not, if properly used, cause damage to the foetal eyes or orbits.

Mechanical pulling devices or jacks to apply traction may also be used routinely in calving cases. The author has found that the H-K calf puller illustrated below (Plate 26) has been an invaluable aid in bovine obstetrics especially in recent years when little help has been available on farms. A favourable report was given by Ingram (1965) shortly after the instrument was introduced into Britain.

PLATE 25



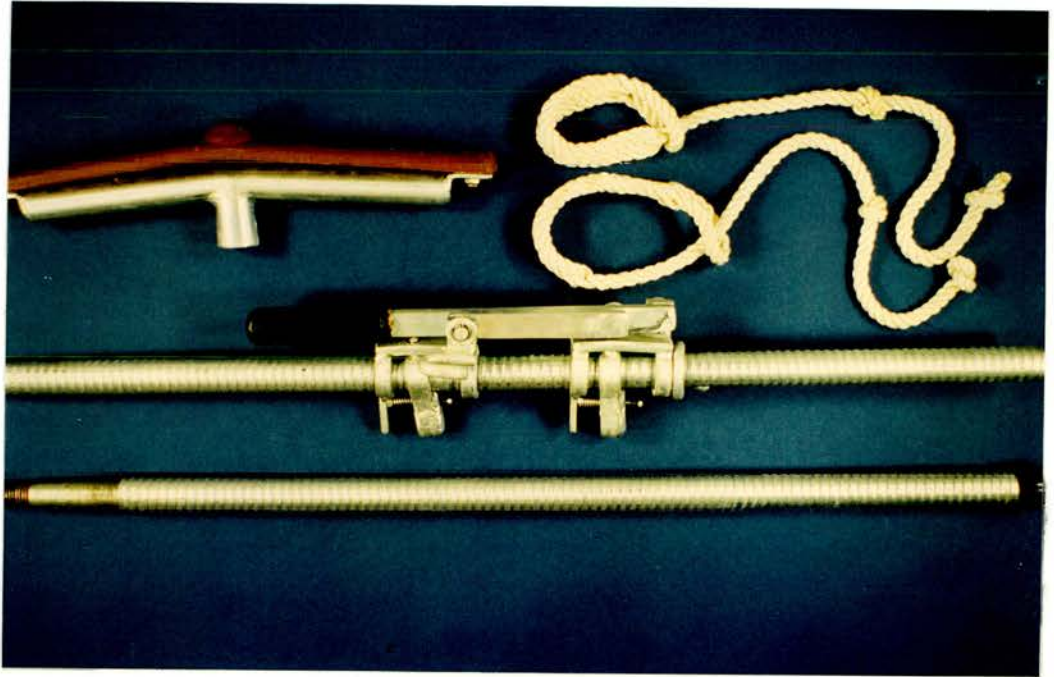
Obstetrical hooks including eye-hooks - the two small eye-hooks are shown threaded into a calving rope ready for use. Also illustrated are examples of a blunt and a sharp obstetrical hook which were used to apply traction or retrieve deviated parts.

Many authors including Seeman (1967) have expressed little enthusiasm for such instruments. Seeman commented 'It is a dishearteningly unprofessional oversimplification to approach the problem with only a jack'. Hindson (1978) warned of the tremendous force generated by the H-K calving aid. The device was capable of exerting a force of 400 kg which compared with a 290 kg force exerted by traction applied by three men. The natural calving expulsive forces were, in comparison, only 75 kg.

In some European countries the use of mechanical pulling devices is forbidden by law (Jackson, 1981). In Denmark the Animal Protection Act 1950 states 'It is not allowed to use a block and tackle, winch or any kind of mechanical gear, horse or motor vehicle to deliver a foetus'. Despite this ruling some Danish farmers have imported the H-K puller from Germany where its use is not banned (Rasbech, 1982, personal communication). Dutch law states 'It is a penal offence to use a

machine for pulling or animal pulling power to deliver a calf' whilst in Sweden 'Mechanical obstetrical instruments may be used only under the supervision of a veterinary surgeon'.

PLATE 26



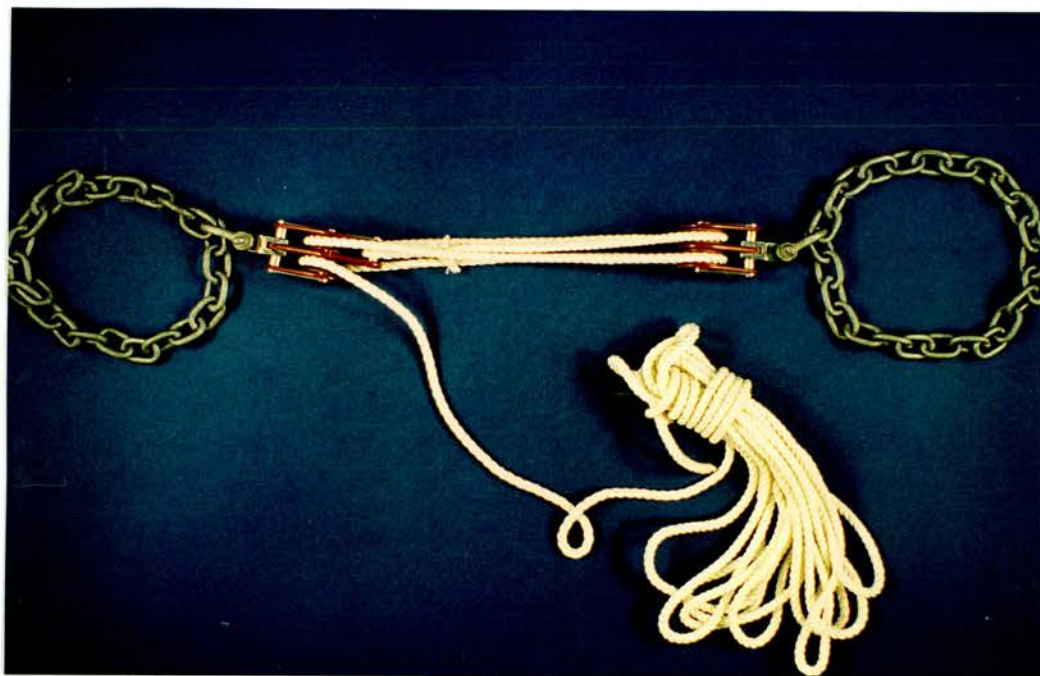
H-K calf puller - shown here in its component parts. Also illustrated are the short knotted calving ropes designed for use with the instrument.

Other obstetricians prefer to make use of an obstetrical pulley illustrated below (Plate 27) to apply traction, but an anchorage point behind the cow is required for the use of such instruments. One such protagonist was Wynn-Lloyd (1923).

Good (1908) illustrated and recommended an 'anti-friction' obstetric pulley which was strong, light and had ball-bearing pulley blocks. He found that the device produced an even and smooth pull and that it could stand forces of up to one ton before breaking. In unskilled hands it would, with such enormous force available, have undoubtedly proved extremely dangerous. Ryan (1930) was unhappy that excessive traction might be applied using a pulley block and preferred to use a long rope passed around a tree or wheel and then threaded

through itself forming a slip knot pulling the calf towards the fixed attachment.

PLATE 27



Obstetrical pulley

Kingman (1955) advocated the use of a block and tackle mounted on a tripod, the feet of which were placed around the vulva of the cow, thus removing the need to find an external attachment point for the pulley. Mechanical pulling devices are by no means new inventions and Fleming (1877) illustrated 'Baron's obstetric machine' which was 'made in France and had received the highest praise'. A large collar connected to a flange was placed against the cow's buttocks and the calf was extracted using a screw windlass coming through the flange. Somewhat similar devices were described by Bedel (1903b) and by Nakama et al. (1974).

In addition to obstetrical equipment, a supply of drugs is also required. Local anaesthesia for epidural, paravertebral or local infiltration anaesthesia may be required. Antibiotics for parenteral or local application should also be available. Tetanus antitoxin will be required where there is a risk of faecal contamination. Clinical

signs of tetanus after assisted parturition have been reported in cattle by Richardson (1924) and Weighton (1927) - the latter author believing that the cow was particularly susceptible to the disease after calving. A fatal case of gas gangrene was described in a cow after treatment of dystocia despite prophylactic use of antiserum (Weinberg et al., 1937). Ecbolics such as oxytocin or ergometrine are also necessary to encourage prompt uterine involution and expulsion of the placenta. Suture material to repair vaginal or perineal laceration and an appropriate surgical kit for caesarean section or embryotomy may also be required.

Dress for the operator

The dirty conditions encountered by nineteenth century veterinarians were vividly described by Fleming (1877) who recorded 'cows and mares often inhabit close, foul stables with almost a poisonous atmosphere. Here the veterinarian must do his duty - cold, wet and dirty'. The need for some impervious protective clothing and has been emphasised by Williams (1943). The modern veterinarian would probably choose either the rubber suit and boots recommended by Kingman (1955) or the clean washable apron or parturition overall favoured by Rosenberger (1979).

Broad (1873) wore a loose washable gown without sleeves whilst Fleming (1877) noted that his friend, Mr. Cartwright of Whitchurch, employed a large, thick and long woollen sleeveless vest which buttoned close up around the neck. Fleming noted 'this is very suitable for such cases as it not only admits of the shirt being removed but besides keeping the operator's clothes clean, it prevents him from catching cold'. Other authors favoured oilskin trousers (Anon., 1896a) or a gaberdine smock (Anon., 1897). Clark (1894) used a loose jacket without sleeves noting that it 'lessened the risk of cramp'. De Bruin (1901) used a flannel shirt and also advised the use of leather kneepads to protect the knees. Students of obstetrics at that time appeared by modern standards somewhat overdressed whilst working with phantoms at Utrecht. The clothing is illustrated below (Plates 28 and 29).

PLATE 28

19th century veterinary student at Utrecht - the student is shown working with a phantom cow practising obstetrical manipulation.

PLATE 29

19th century veterinary student at Utrecht - practising embryotomy using a phantom uterus. (Note Plates 28 and 29 are reproduced from de Bruin's 'Bovine Obstetrics' by kind permission of the publishers)

Richardson (1901) used an obstetric shirt without sleeves which reached below the knees, made of thick woollen material. This he found 'enables you to have your linen clean to return in, which is not only better regarding appearance, but also in regard to comfort'.

Most veterinarians prefer to carry out obstetrical work with unprotected hands but Sloss and Dufty (1980) advised the use of gloves should the operator have a sensitive skin. The modern plastic arm gloves are unfortunately of insufficient strength for use in obstetrical cases but latex rubber gloves are available (Schuijt and Ball, 1980). Fleming (1877) was well aware of the dangers of an infected uterus to the operator, noting that exposure to such a uterus could lead to 'most serious septic disease and even to loss of life'. Dangers to the hands and arms were also important and Fleming reported cases in which unpleasant cutaneous eruptions had developed. In serious cases the condition might lead to surgical amputation of part of the arm. Gamgee (1858) described and illustrated the unpleasant problems he suffered with his arm following attendance upon a neglected case of dystocia. Severe pruritis and a diffuse rash developed and were followed by the development of pimples and suppuration. Such was the discomfort that Gamgee reported he was 'unable to lecture for a day and was tormented for six weeks'. Williams (1943) advised that persons with sensitive skin should wash repeatedly during obstetrical work and apply protective lubricant to their skin at regular intervals.

Cleanliness and hygiene

The importance of cleanliness and hygiene was emphasised by Benesch (1938) who considered asepsis and antisepsis to be the two most important basic principles of obstetrical work. Strict attention to cleanliness has been emphasised by many authors including Tutt (1944) and Rosenberger (1979). An author who signed himself 'X' (Anon., 1896a) also stressed the need for cleanliness at parturition and noted that one might occasionally get away with poor hygiene but 'that sooner or later losses would occur'. Benesch (1938) advised that sterile instruments should be carefully laid out before use but as Taylor (1903) observed, such sterility could easily be destroyed by the patient or by inexperienced helpers.

For routine pre-operative care, Johnston and Sloss (1967) considered that scrubbing of the cow's skin and also the operator's hands and arms with soap and water was at least as important as the bactericidal action of disinfectant. Schuijt and Ball (1980) advised tying the cow's tail to her neck and thoroughly cleansing the perineal region with soap and water. Despite these precautions, there is a continued risk of contamination of the site of operation by defaecation necessitating repetition of the washing and cleaning processes.

Lubrication

Some form of lubrication is necessary in obstetrical cases to aid introduction of the hand, to protect both the skin of the operator and the lining of the maternal birth canal and also to ease passage of the foetus through the birth canal. Such lubrication is especially necessary in longstanding cases where natural lubrication has been gradually lost. A number of lubricants are available and which one is used depends on personal preference and availability. Rowlands (1812) advised obstetricians to 'supple the arm well with warm water and annoint it with fresh hog's lard'. Broad (1873) and Straiton (1957) were other protagonists of lard as was Richardson (1901) who used either unsalted lard, olive oil or soap and water as a lubricant. Rainey (1957) preferred linseed mucilage to lard. Clark (1894) also used soap and water to which he added carbolic acid, finding the mixture 'very good'. Soap and water was also preferred by Johnston and Sloss (1967) and by Sloss and Dufty (1980), but the latter authors considered the use of soap and water had the disadvantage of rapidly removing any persisting natural lubricant. Butter, grease or oil were recommended by Fleming (1877) but he did not identify the oil he used. Schuijt and Ball (1980) found that although mineral oils produced good lubrication, they were inclined to produce granulomata in the birth canal. Grøndahl (1963) recommended the use of what he called an amniotic fluid substitute - sodium carboxy methyl cellulose. He stored the substance in long plastic bags, one end of which could be inserted deep into the uterus, to deposit the contents in the position where they would be most helpful. Schuijt and Ball (1980) also commented on this product noting that its consistency could be diluted as necessary according to need. The author has not used this

particular product but has found a solution of soap-flakes and liquid paraffin most helpful in cases where severe loss of foetal fluids has occurred. Plenty of lubricant should be used (Kingman, 1955) and should be introduced as soon as any sign of dryness becomes apparent in the birth canal (Schuijt and Ball, 1980). Jackson (1963) stressed the need for lubricant to be placed alongside the calf and squeezed between the foetus and the birth canal.

A number of commercial obstetrical lubricants are available but are rather expensive. Examples include 'Lubrel' (Dale's Pharmaceuticals) - a synthetic colloidal gel containing 0.25 per cent benzalkonium chloride and 'J. Lube Powder' (Jorgensen Pharmaceuticals) - a powder containing 25 per cent polyethylene polymer and 75 per cent of dispersing agent. Sloss and Dufty (1980) advised that following the birth of the calf any added fluids still remaining in the uterus should be removed by siphonage.

Examination of the patient

Most textbooks of veterinary obstetrics have given a comprehensive account of the methods of examination of the cow and especially of the genital tract in parturient animals. Excellent descriptions have also been given by Jackson (1963), Rosenberger (1979) and by Schuijt and Ball (1980). Rosenberger's account was particularly comprehensive and meticulous and he advised that careful history taking should precede the obstetrical examination. In some cases, however, the pressing nature of the case might require that a full case history could not be taken until after parturition was completed. According to Rosenberger the main factors to be elucidated during history taking were the number and course of previous calvings, the duration of the current pregnancy, the cow's health during pregnancy and the time and nature of the first signs of calving. He advised that the timing - where possible - of uterine contractions, the time of placental rupture and any sign of unnatural behaviour should be recorded. Details of any lay interference and the form which this took should also be ascertained and noted carefully.

A brief assessment of the general health of the cow should be made and should the animal be unable to rise, Rosenberger advised careful examination especially of the locomotor, circulatory and

neurological systems. Examination of the parturient patient commenced with an inspection aimed at assessing signs of ill-health especially related to the genital tract. The shape and symmetry of the abdomen should be assessed and Rosenberger advised that special attention be paid to the right flank of the cow where he believed vigorous foetal movement might be a sign of premature placental separation. The vulva was also inspected for signs of displacement such as might be observed in cases of uterine torsion and for evidence of foetal parts or membranes. The external pelvic dimensions were also assessed as was the degree of relaxation of the sacro-iliac ligaments. Visual inspection of the abdomen was followed by palpation for evidence of abnormal tension associated with disease and for evidence of foetal presence. Rosenberger believed that in cases where excessive foetal fluids were present what he termed the 'rebound effect' following ballotment of the foetus was no longer evident.

Careful inspection and palpation of the udder was also advised and the author of this thesis believes this to be essential advice. The problem of environmental mastitis in modern dairy herds is a serious one and the disease may develop surreptitiously. The cow may show little sign of the problem until the disease is advanced and she is gravely ill. Early detection and treatment have been found to provide the only hope of saving the animal in such cases.

Much of the above examination is carried out almost sub-consciously by the experienced practitioner who makes his observations and assembles details of the case history in discussion with his client as he prepares to carry out vaginal examination. Any sign of general ill-health must be carefully followed up by detailed clinical examination and where necessary treatment instituted before proceeding to the detailed obstetrical examination.

Vaginal examination

Undoubtedly vaginal examination may more easily be performed in the standing animal and whenever possible the cow should be encouraged to rise. Prior to introducing the hand into the birth canal, Rosenberger (1979) advised visual inspection of the vestibule to assess moistness, colour, signs of haemorrhage or pressure necrosis of the mucous membranes. Following careful washing and disinfection of the

vulva and perineum the operator's lubricated hand was inserted (with fingers and thumb arranged in the form of a cone) into the vulva and palpation of the birth canal, foetus and foetal membranes was carried out. Should excessive straining occur at this stage which interferes with careful examination, epidural anaesthesia may be administered.

Rosenberger advised that during examination of the birth canal, the degree of dilation, together with the slipperiness and elasticity of the mucosa should be assessed. Any evidence of malformation or damage was noted as was the degree of cervical dilation. Should the cervix not be fully dilated Rosenberger believed that it might be possible at this stage to ascertain whether the failure of the cervix to dilate was temporary or permanent. If temporary (as in the early stages of labour when it was not fully dilated) the cow would not be exhausted, natural lubrication would be present, and the foetus would probably be alive. Where the problem was more permanent, the dam would be depressed, the birth canal dry and rigid and there might be evidence of foetal death. During vaginal examination the uterine arteries might be palpated through the vaginal wall and might be found to be displaced in cases of uterine torsion.

Parkinson (1812) considered that the ability to estimate the degree of cervical dilation might be acquired by careful practice. He wrote 'I must earnestly recommend a correct acquaintance with the os uteri by examination, by which will be established a correspondence between the fingers and the mind or between the sense of Touch and the Sensorium, sufficient to give just confidence and security against error'.

Following examination of the soft tissues of the birth canal, the bony pelvis was also examined per vaginam for signs of damage and for estimation of size. The foetal membranes also provided evidence of foetal health and well-being. In many cases the chorio-allantois was not seen, having ruptured spontaneously before professional help was called. If present, its thin transparent and bluish appearance differentiated it from the thicker-walled, white-coloured amnion. In fresh cases, the membranes felt slippery and elastic, whilst in neglected cases their texture was leathery, oedematous and had an unpleasant foetid smell. Both allantoic and amniotic fluids might be encountered, their absence, or the presence of an unpleasant odour,

might suggest the presence of intra-uterine infection. Meconium may colour the amniotic fluid yellowish-green (Sloss and Dufty, 1980) and its presence may suggest the development of foetal anoxia. Leslie (1959) did not consider that meconium staining of the amniotic fluid was necessarily a serious sign in the human foetus and advised that observations should be interpreted in relation to other parameters including foetal heart rate. Dillman and Dennis (1976) observed that ruminant amniotic fluid might become blood tinged twelve hours after foetal death.

Rosenberger (1979) proceeded next to examine the foetus to ascertain its presentation, position, posture and viability. Earlier Fleming (1877) had offered sound advice regarding the differentiation of the fore- and hind-limbs of the foetus. He noted 'the shape of the joints and their mode of flexion must be taken into account'. In the fore-limb the fetlock and carpus flexed in the same direction, whilst in the hind-limb the fetlock and hock flexed in opposite directions. The author of this thesis has found that unless the examination is carried out with extreme care it may be possible to confuse the identity of the limbs. Should error in identifying the lower portions of the limbs occur, this error may be further compounded by mistaking the elbow joint for the hock joint and the shoulder joint for the stifle. The relationship between the limbs and head (or in posterior presentation the limbs and the tail) should be carefully checked, lack of space often proving a hindrance.

Evidence of foetal life, according to Rosenberger (1979) might be obtained by observing the response of the foetus to pressure on the feet, eyeballs, scrotum or umbilicus. Inserting the fingers into the calf's mouth might produce a sucking reflex whilst in the posterior presentation, the anal reflex might be found helpful. The author has, however, frequently found that these reflexes may be quite unreliable, especially when the foetus is wedged tightly into the birth canal. Sjoberg (1927) observed that 'reflex irritability' was increased in hypoxic calves and reported that firm pressure exerted upon the foetal eyeballs might cause the maldisposed calf to struggle and adopt the correct posture for normal birth.

Routine monitoring of foetal heart rate and blood gas parameters during birth has not yet become standard practice in bovine obstetrics.

Undoubtedly such observations would be of great value - as they are in human obstetrical work - especially if surveillance was maintained throughout the second stage of labour. Although professional assistance is normally only summoned when serious difficulties have arisen in second stage labour, even at this late stage a more accurate ability to assess the foetus would be extremely valuable.

Mitchell (1973) reported his observations, made by doppler ultrasound, of foetal circulation in a large number of pregnant cows. He used a transducer mounted in a rectal probe and prophesied that such observations would be of value in monitoring foetal life during pregnancy. He found, however, that the position of the gravid bovine uterus made it less accessible to a rectal probe than that of the pregnant mare. He also found that in two cows in which foetal death occurred his observations revealed no evidence of impending difficulty. The author of this thesis (Jackson, unpublished observations) has occasionally used a doppler transducer (of the rectal probe variety) applied directly per vaginam to the foetal thorax in utero to monitor foetal heart rate in cases in which foetal distress was suspected. In one such case an extremely low foetal heart rate prompted rapid delivery. A meconium stained foetus was delivered and great difficulty was experienced in establishing spontaneous respiration. Richardson and Higgins (1981) were able to detect signs of foetal life using an external doppler ultrasound probe applied to the shaved skin of the cow's ventral abdomen. Foetal heart rate could be observed from day 120 of gestation. It is unlikely that, as a result of maternal movements, such external monitoring could be maintained accurately during birth.

Foetal electrocardiography was proposed by Larks et al. (1960) and Too et al. (1965, 1967) but the superimposition of maternal movement on the recording would, especially during parturition, make the method of little practical value. Earl et al. (1980) monitored the heart rate of a bovine foetus before, during and after birth using a transmitter implanted into the foetus at day 240 of gestation. They found that the baseline heart rate at that stage was 135-175 beats per minute. During second stage labour the heart rate became erratic and fell to approximately 100 beats/minute. After birth the heart rate rose to 225 beats/minute but when the calf commenced its first nursing episode the heart rate fell again to the pre-partum rate.

Massip (1980) observed that blood pH was significantly lower and pCO_2 was significantly higher in calves which had been born after dystocia than in those which had experienced natural birth or had been born by caesarean section. Monitoring of these parameters during foetal delivery would be most useful in assessing the degree of acidosis and anoxia within the foetus but unfortunately blood samples would less easily be obtained from the calf than from the human infant. Wailenhofer and Brattig (1975), however, observed that it was possible to obtain a continuous supply of bovine foetal blood from the superficial veins of either metacarpus or metatarsus.

Foetal breathing in utero has provided dramatic evidence of life in a number of cases (Stevens, 1922; Stockman, 1967 and Ward, 1967). Such activity would normally result from a failure of the placental circulation and foetal delivery should take place without delay.

Foetal death may be suspected in the absence of the positive signs of foetal life discussed above but without the aid of monitoring devices the clinician may on occasion be unsure of the living state of the foetus until birth is complete. Twelve hours after the death of the foetus blood staining of the amniotic fluid may be seen and 72 hours after death collapse of the foetal eyeball may be detected (Dillman and Dennis, 1976). Corneal opacity, which may be the most obvious abnormality seen in the stillborn calf after birth, develops twelve hours post mortem. Sterile autolysis of the foetus commences immediately after foetal death but, should bacteria gain access to the foetus, putrefactive changes including the development of emphysema may occur (Sloss and Dufty, 1980). Grünert and Ahlers (1969) reported that earlier evidence of foetal death during pregnancy might be obtained by estimation of urinary oestrogen levels in the cow. Death might be suspected when urinary oestrogen was less than $0.5 \mu g/5 \text{ ml}$. Foetal death is not necessarily followed by dystocia and Dufty (1974) observed that delivery of the stillborn foetus required on average less than half the time taken for the birth of a living foetus. In cases in which foetal death has been followed by decomposition and loss of foetal fluids, delivery can be extremely difficult.

Signs of maternal ill-health including septicaemia and toxæmia will be seen in a proportion of animals before and after removal of a dead and decaying foetus. Other animals show little sign of ill-health

and cases have been recorded in which reasonable milk production or fattening followed failure to deliver a dead and infected foetus from the uterus (King, 1834a; Pringle, 1896; Campbell, 1921).

Rosenberger (1979) found that occasionally rectal examination might be of value during early assessment of obstetrical cases especially when obstruction of the birth canal, due to such causes as uterine torsion or cervical non-dilation, were present.

Richardson (1901) believed it was very unwise to express an opinion on prognosis too early during an obstetrical consultation. He advised 'do not express an opinion until you are perfectly sure of the presentation you have to deal with and of the possible results'. Whenever possible the temptation to make frequent vaginal examinations should be resisted and as much progress as possible should be made during each insertion of the arm (Gaskell, 1965).

Diagnosis of the cause of dystocia and the plan for its treatment

Having carefully assessed the findings of clinical and of vaginal examination it may be possible for the clinician to diagnose the cause of dystocia and to plan what course of action may be necessary to deal with the problem. The importance of early decision taking was emphasised by Wright (1958). He offered the following sound advice 'If by skilful manipulation and careful judgement it is possible to deliver the animal per vaginam without significant injury, then it is always our duty to do so. But equally so in those cases in which it is impossible safely to deliver her in this way, the sooner the fact is recognised the better, for nothing exhausts the animal more quickly than futile efforts to effect vaginal delivery'. Benesch (1938) believed that there were five possible courses of action which might be adopted in cases of bovine dystocia. These were:

1. correction of maldisposition,
2. extraction of the foetus by force, uncorrected,
3. repulsion,
4. embryotomy,
5. caesarean section.

The interpretation of Benesch's list is somewhat difficult since in most cases of foetal maldisposition, repulsion of the foetus is generally immediately necessary to allow any manipulation to take place.

A sixth possible course of action, namely euthanasia, might be added as the course of action in the rare but hopeless case.

It has been suggested (Ballarini et al., 1978; Greene, 1981) that in certain circumstances parturition might be interrupted by injection of clenbuterol, causing temporary suppression of myometrial activity. Thus a dystocia case occurring late in the evening might be 'suppressed' until the following morning when more help was available. Although it has been shown that such action would normally have no deleterious effect upon foetal survival, in the author's view many farmers would be unhappy with this course of action.

Grünert and Verhulsdonk (1980) reported the effects of oral administration of clenbuterol to 186 cows and heifers in the last few days of pregnancy. The drug was administered once daily at 9.00 p.m. from day 276 and day 280 of gestation respectively to heifers and cows. The occurrence of night calving was reduced by 47 per cent and the authors considered that the process of parturition in heifers was slowed down and thus made easier following administration of the drug. In a study involving Spring calving beef cows which received a large proportion of their food at a single controlled feeding time Lowman et al. (1981) found that the time of calving might be influenced by the time of feeding. By feeding the animals at 10.00 p.m. instead of at 9.00 a.m. it was found that the number of animals calving between 6.00 a.m. and 10.00 p.m., when supervision was available, was increased by twenty per cent.

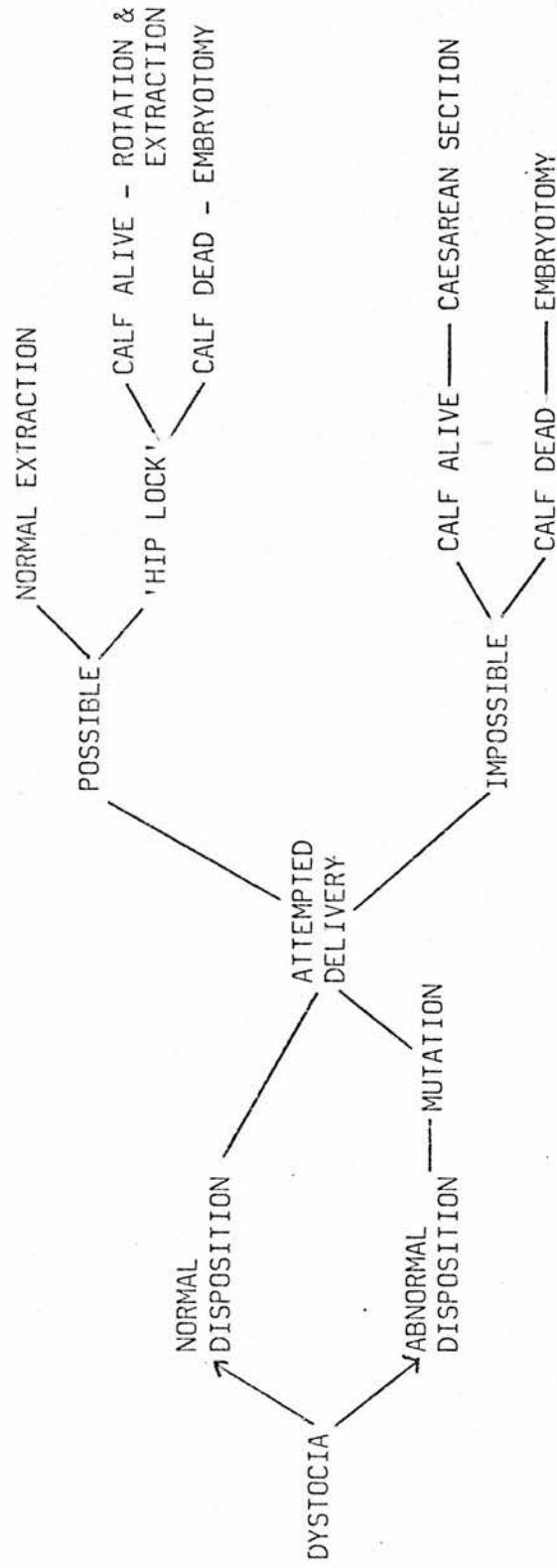
Schuijt and Ball (1980) designed a flow-diagram which summarised the possible courses of action to be taken in a case of dystocia. It is reproduced in modified form below (Fig. 1).

Kingman (1955) noted that most cases would 'yield to correction by reposition, flexion or extension of the extremities and moderate traction'. He also believed that early decisions should be made about what could practicably be carried out in the circumstances and environment pertaining at the time.

In their series of 635 cases of bovine dystocia in beef cattle in Australia, Johnston and Sloss (1967) reviewed the obstetrical procedures used to deal with their cases. Their findings were as follows:

Fig. 1

Flow diagram for dealing with bovine dystocia cases (modified after Schuijt and Ball, 1980)



Procedure	%
Traction ± reposition	43
Embryotomy	37
Caesarean section	9
Episiotomy or cervicotomy	2
No treatment	2
Euthanasia	7

The list reveals a very high level of embryotomy, but it must be remembered that Johnston and Sloss were working among semi-wild cattle under range conditions in Australia. In almost every case dystocia was well advanced by the time they were called in and it is possible that some cases, had they been seen earlier, might have been delivered by manipulation and traction. In their series of 200 cases observed in Britain, Morten and Cox (1968) found embryotomy necessary in only ten cases whilst caesarean section was performed in nineteen.

Assistance

Ideally three persons should be available to assist the veterinarian with his work, one to control the head of the animal and two to assist with obstetrical manipulation. When the author of this thesis commenced practice ample help was mostly at hand with neighbouring farmers and their men being willing to attend if necessary. The high cost of farm labour and the mechanisation of arable farming has resulted in a scarcity of help and in many cases only one person will be available to assist and this may be one reason why mechanical aids such as the calf-puller have become so popular. Whenever possible adequate help should be assembled and attempted delivery of the calf postponed until this help is at hand (Smith, 1884). Arthur et al. (1982) wisely advised that the obstetrician should never hesitate to send for the help of a professional colleague if he considered that he might be unable to deliver the foetus otherwise without additional help. As Lawson (1860) observed 'to enable a practitioner to undertake calving work in a proper manner he must have actual experience therein for no amount of reading or oral teaching will make him expert although these means are not to be slighted'. Guidance and advice from an experienced colleague whilst attending a case of bovine dystocia can be of great educational value.

CHAPTER FOURTEEN

MANIPULATIVE DELIVERY

Before assisted delivery of the foetus commenced it is essential that any maldisposition has been corrected and that an attempt has been made to ascertain whether vaginal delivery is likely to be successful. The methods employed to deal with foetal maldisposition have been discussed in Chapter Nine and the various procedures which may be used to assess the probability of successful vaginal delivery were dealt with in Chapters Ten and Thirteen. As Arthur et al. (1982) stressed, however, any plans made for foetal delivery must be tentative and quickly changed if unsuccessful.

The term 'traction' has been used to describe the application of force to the presenting parts of the foetus in order to supplement, or in some cases to replace the natural maternal forces (Arthur et al., 1982). Traction is one of the obstetrical manoeuvres which are available to the veterinarian engaged in foetal delivery, the others being repulsion, rotation and version. Roberts (1971) used the term 'forced extraction' which he defined as 'the withdrawal of the foetus from the dam through the birth canal by means of the application of outside force or traction'.

Although traction is so frequently used as a method of delivery it must nonetheless be regarded as being quite different from normal delivery in which the foetus is essentially pushed from the uterus by uterine and abdominal expulsive efforts. Parkinson (1812) in his thoughtful and advanced discussion of parturition commented thus 'It is worthy of remark that there is an essential difference in the propelling power of the pains and those produced by an extracting power. Impelled by the former, the presenting parts will accommodate themselves to the figure of the aperture and in the whole progress will assume the smallest possible dimensions whilst passing through it. But when an extracting force is employed at the feet only, the legs will be brought forwards to the hindrance of the advancement of the head, which at least ought to keep pace with them'.

Parkinson continued 'In the natural progress of parturition, the feet do not much precede the head and when they are compelled by external force to do so, the thickest parts of the forelegs or elbows will be brought to accompany it and cannot without violence be brought beyond a perpendicular line with the orbits or the largest dimensions of the head'.

Delivery by traction or forced extraction is probably the method most frequently used in assisted bovine parturition and indeed at one time was the only method available. In a review of the records of the Bovine Obstetrical Clinic at Hannover during the 19th and 20th centuries Aehnelt et al. (1971) traced the changes which had occurred in the methods used to deal with cases of bovine dystocia. During the 19th century traction was the main method of delivery employed but in the early years of the 20th century greatly improved instruments for embryotomy were developed and this technique became much more widely used. Following the introduction of flank laparotomy under local anaesthesia in the middle of the 20th century, caesarean section became much more popular as a method of delivery, replacing the technique of traction in doubtful cases. Undoubtedly the increase in value of calves together with more humane consideration for the mother has been instrumental in these changes.

In recent years the Hannover workers recorded a calf survival rate of 66 per cent following delivery by traction and 89 per cent following caesarean section. Caesarean section was now employed in all cases where traction by two persons had been unsuccessful, when there was evidence of obstruction of the birth canal or severe foetal oversize.

In a review of methods used to treat cases of dystocia in primiparous heifers Jackson (1963) found that minor traction only was required to deliver the foetus in 90 per cent of cases. Sloss and Dufty (1980) surveyed the treatment required in 2480 cases of bovine dystocia in Australia and found that traction was successful in achieving delivery in 83.6 per cent of dairy cow cases and 64.7 per cent of cases involving beef cows.

Winstanley (1973) warned that whenever traction was required at parturition careful consideration should be given to the welfare of both dam and calf. Ideally neither should be damaged during birth.

The circumstances in which forced extraction of the foetus might be required were listed by Roberts (1971) and included:

- 1) uterine inertia when the foetus had failed to engage in the birth canal and thus stimulate straining,
- 2) following the administration of epidural anaesthesia,
- 3) following correction of foetal maldisposition,
- 4) cases of relative foetal oversize,
- 5) delivery through the small birth canal of primiparous cattle,
- 6) obstruction of the birth canal by tumour, fat deposit etc.,
- 7) foetal emphysema,
- 8) cases of posterior presentation in which foetal asphyxia was threatened.

The state of dilation of the maternal birth canal may exert a considerable influence on the ease with which vaginal delivery can occur. Schuijt and Ball (1980) believed that foetal delivery should not be attempted until the birth canal was dilated and suggested an interesting method by which dilation might be enhanced by the obstetrician. Following lubrication of his arms and the birth canal they recommended that the operator should clasp his hands together with fingers interlocked. Both arms were then gently but firmly inserted into the vagina and gently rotated into and out of that organ. The operator's arms, with elbows held closely together could also be inserted in a parallel position more deeply into the birth canal and once thus inserted, the elbows could be abducted causing further dilation of the birth canal.

The presence of foetal membranes within the birth canal may prevent access to the extremities of the foetus to which traction is to be applied. Quite frequently during vaginal examination the foetal amnion may be found to be intact and in the author's view should not be prematurely ruptured unless it is intended to proceed with immediate delivery. Frequently however during palpation of the foetus and adjustment of its extremities rupture of the amnion will occur and the membrane must in any case be ruptured when an attempt is made to apply ropes or chains to the foetal head or limbs. Rupture of the amnion may be achieved by thrusting the finger through the membrane and is followed by the escape of amniotic fluid. Edwards (1906) noted that there was a tendency for lay persons to

rupture the foetal amnion early in second stage labour. This practice was to be deprecated since in his view it might lead to a failure of the cervix to dilate, loss of uterine contraction and the lubricant qualities of the amniotic fluid. The likelihood of foetal maldisposition was also increased. Studies conducted by Semchenkov (1972) on four dairy herds concluded that early loss of foetal fluids might lead to an increase in foetal stillbirth rate, neonatal mortality and post-parturient disorders.

The authors of the majority of textbooks of veterinary obstetrics agree that traction should be applied to the head and both forelimbs when the foetus is in anterior presentation (Fleming, 1877; Benesch, 1938; Williams, 1943; Roberts, 1971 and Sloss and Dufty, 1980). Arthur et al. (1982) also considered that traction applied in this fashion 'greatly expedited birth'. In many cases however the author has found that when the foetal head and forelimbs are fully engaged in the maternal pelvis delivery may be satisfactorily achieved by application of traction to the limbs only. In such cases insufficient room may be available for a rope to be attached to the foetal head (and eyehooks may be unavailable) and unsuccessful attempts may result in the foetal head being accidentally repelled back into the uterus. When the head is not used as a point of traction great care must be taken to ensure that it does not become displaced and fall away from the pelvic inlet. Benesch (1938) warned that if the foetal head was not maintained in its correct relationship with the forelimbs the neck might become 'telescoped' and hence thickened with resultant obstruction to birth. Sloss and Dufty (1980) shared this view but also noted that if, conversely, the head became too advanced in its passage through the birth canal, elbow flexion might develop and this might cause dystocia.

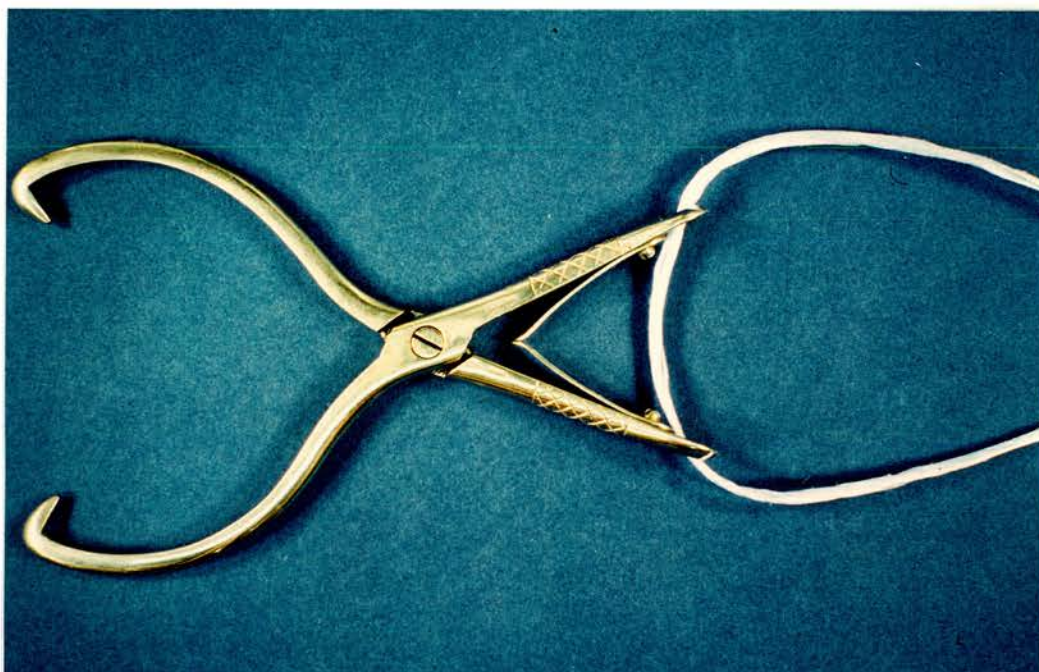
In the posteriorly presented foetus traction can normally only be applied to the hind limbs but, should the foetus be dead, an anal hook such as Obermeyer's hook, illustrated below (Plate 30) may be used to apply additional traction to the foetus. The hook is introduced into the foetal rectum and hooked over the pelvic brim to obtain a secure hold.

PLATE 30Obermeyer's hook

Fleming (1877) advised that ropes should be applied to any foetal extremity encountered in the birth canal and that if necessary the extremity - with rope attached - could be returned to the uterus whilst appropriate manipulation was performed. The author has found that when it has been necessary to attach a rope to the foetal head, this should be done before ropes are applied to the limbs thus allowing unobstructed access to the head.

Various devices have been recommended with which to apply traction to the foetal head. Benesch (1938) favoured the use of eyehooks whilst Roberts (1971) advised the use of Krey's hooks. These self-tightening hooks, illustrated below (Plate 31) have extremely sharp points and would in the author's view be unsafe to use in the living foetus especially if applied to the eye sockets.

Somewhat similar hooks with blunted extremities and with a single hinge action (Roberts' hooks) are illustrated below (Plate 32) and might possibly be used with greater safety than Krey's hooks.

PLATE 31Krey's hooksPLATE 32

Roberts' hooks - a cord has been threaded through the handles to which traction may be applied.

The application of eye-hooks may be particularly useful when little room is available in the birth canal and in similar circumstances Williams (1943) recommended that traction be applied through a rope attached to the lower jaw of the foetus. Roberts (1971) considered that it was permissible for one man to apply traction in this way but earlier Fleming (1877) had warned that fracture of the mandible might easily occur. Cartwright (1842a) described a case in which the foetal teeth became dislodged after traction was applied to the lower jaw during delivery whilst Heatley (1932a) reported the occurrence of a jaw fracture in similar circumstances. Williams (1943) suggested that the jaw snare could be more securely attached by passing the rope through the floor of the foetal mouth and advised that, even in the living calf, the operation could be easily and safely performed. Such a procedure might easily cause damage to vascular and other tissues in the calf.

A halter may be applied to the foetal head and after much experiment Schaak (1848) described the use of his adjustable halter which later received favourable comment from Fleming (1877). Alternatively a simple head snare may be looped around the foetal head. Also known as a 'war bridle' (Roberts, 1971) the snare is a length of calving rope passed over the poll of the foetus and tightened through the mouth. Sloss and Dufty (1980) and Arthur et al. (1982) believed that this device was the most satisfactory method of attaching a calving rope to the foetal head. Roberts (1971) offered a word of caution, noting that when traction was applied and the snare tightened, the calf's mouth might be forced open exposing both the operator and the maternal birth canal to the risk of injury from the teeth.

The author has used a head snare in practice on many occasions but found that its attachment might prove difficult at times. In his view, it is essential that the loop is made larger than its final required size before it is inserted into the birth canal. Once the loop is within the cow enlargement can be extremely difficult. The loop is carried over the foetal poll and placed around the base of the skull, caudal to the ears and is then carried through the calf's mouth before being pulled tight. Before final tightening a check should be carried out to ensure that the snare is still securely

behind the foetal poll. Should it not be securely attached the snare will be pulled off the head as soon as traction is applied. Straiton (1957) reported that he found a length of cord looped over the foetal poll a satisfactory method of applying traction.

Great care must be taken when attaching calving ropes or chains to the foetal limbs that damage does not occur. The foetal hooves may be pulled off and the fetlock joint injured if ropes or chains are applied too low. To avoid the risk of such damage Fleming (1877) and Arthur et al. (1982) recommended that ropes should be attached above the fetlock joint. Roberts (1971) and Sloss and Dufty (1980) considered that cords might be safely attached either above or below the fetlock joint whilst Johnston and Sloss (1967) recommended that two snares should be applied to each leg, one above and one below the fetlock joint.

The application of the ends of a single rope to both foetal forelimbs, although still practised by some farmers, was deplored by Benesch (1938) who considered that it was impossible, using such a device, to maintain one limb in advance of the other during foetal delivery. Williams (1943) believed that the breaking point of calving ropes should not be too high so that excessive traction might not be applied. Sudden breaking of a rope can be highly dangerous and might produce a similar effect to that described by Hughes (1930) who reported that severe injuries were sustained by an assistant who was crushed by fellow helpers when an impacted foetus, being delivered by traction, was suddenly released from the maternal pelvis.

Fleming (1877) described two methods by which cords might be carried into the birth canal for attachment to the foetal limbs. The cord could be carried upon a 'cone' made up of the operator's pointed fingers and thumb or could be looped over his fingers and guided into the birth canal with the hand held flat. Unless the cord was carefully attached and tightened, Williams (1943) warned that it might easily fall out of the vagina once the operator's hand was removed. The author believes that this problem may be avoided if the foetal limb is gently but firmly pulled through the vulval lips before application of the calving rope. The rope is guided into place and supported by the operator's left hand, which prevents the rope slipping down the limb, and is then pulled tight by the operator's

right hand. Once the rope is in position gentle traction should be maintained upon it whilst the operator deals with the second limb.

There has been considerable discussion in the literature concerning the number of assistants required to apply traction. Fleming (1877), commenting upon the divergence of views, noted that whilst some obstetricians believed that the pulling power of two men was sufficient, others did not hesitate to use ten men. Those who advocated the use of many helpers believed that 'the patient suffers more from protracted labour than from powerful traction - and not infrequently their success justifies their boldness'. Munro (1894a) was adamant however that no more than three persons should ever be employed to apply traction. Benesch (1938) believed that 'five powerful assistants' might legitimately be used whilst Arthur et al. (1982) considered that for simple cases the help of two persons to apply traction was required and for more severe cases four. Roberts (1971) firmly believed that the operator should not be personally involved in the application of traction but rather should conserve his strength and direct the operation. Unfortunately such is the scarcity of available help - already alluded to in Chapter Thirteen - that the operator has usually no option but to be involved in the application of traction.

When assistants are employed to apply traction, it is essential that whilst their pulling strength should be carefully controlled, it should also be used to maximum efficiency. Straiton (1957) advised that the calving box floor should be sprinkled with grit to enable both assistants and the animal to obtain a satisfactory non-slip grip with their feet. Bedel (1903a) advised that if only two assistants were available the cow should be cast and the assistants should apply traction sitting behind the animal with their feet pressed against the cow's hindquarters. More recently Schuijt and Ball (1980) recommended that a ladder should be placed flat on the straw behind the recumbent cow, in contact with her buttocks, against which the seated assistants might brace their feet.

Calving chains are provided with handles which may be attached anywhere along their length and which enable traction to be applied efficiently. Calving ropes may be attached to short lengths of broom handle by means of a clove-hitch knot (Bedel, 1903a). When damp

however such ropes, under tension, may become extremely tight and difficult to untie following use (Benesch, 1938). The author of this thesis has found that this problem may be avoided if a small bunch of clean straw is included within the knot.

Traction should be applied with great care and used to assist (when these have not been in part abolished by epidural anaesthesia) the natural maternal forces. Simonds (1849) advised 'assistance should only be given at the continuance of each alternate pain' and considered that 'by steady adherence to this, resistance can be overcome and the life of the mother and young preserved'. Shawcross (1939) was another of many authors who advised that traction should be restrained and intermittent, allowing time for the vagina to expand and reducing the possibility of maternal damage. Frequent pauses between bouts of maternal straining, with further lubrication and re-assessment of the foetal position, were recommended by Arthur et al. (1982). As the foetus approached the pelvic inlet these authors advised that traction should be applied to one forelimb and then the other, allowing one foetal shoulder to enter the pelvic inlet in advance of the other. Once the shoulders had passed through the maternal pelvis, all three ropes should be pulled together.

The direction in which traction is applied is extremely important, and in his advice to herdsmen Harward (1673) cautioned 'be sure to draw downwards, draw hard but not rashly'. Fleming (1877) believed that traction should be directed straight behind the cow but studies of the shape and form of the maternal pelvis by Benesch (1938) suggested that more careful control of the direction of traction was necessary. Benesch discussed the concept of what he termed the 'pelvic axis or guiding line' which had in fact been alluded to although not fully interpreted by Fleming (1877). The pelvic axis - an imaginary line - connected the centre points of the whole of the pelvic section and represented, with its curvature, the course of direction of the genital canal. Benesch noted that the pelvic axis of the cow, when considered in a cranio-caudal plane, formed a slightly S-shaped curve. Commencing at the pelvic inlet it first ascended, then assumed a more horizontal course and finally rose again towards the tail. On the basis of the course of the pelvic axis, Benesch advised that traction should first be applied in

a slightly dorsal direction towards the root of the tail. Once the foetus had entered the pelvic cavity traction should be directed downwards and parallel to the maternal hind limbs. By delivering the foetus in a line he described as 'the arc of a circle' Roberts (1971) observed that the foetus was able to take full advantage of maternal pelvic size whilst maintaining a profile which reduced its own size. When traction was applied to the head and fore limbs of the foetus in a downward direction, the abdominal muscles of the foetus were relaxed and allowed the foetal pelvis to be forced backwards and upwards. This not only reduced the sacro-pubic diameter of the foetal pelvis but also caused the foetus to pass through the maternal pelvis at its most dorsal part where the lateral diameter was greatest.

During natural birth abdominal straining with associated muscular contraction causes the maternal pelvic inlet to be pulled into a more vertical position in relation to the vertebral column and the cow assumes an arched-back posture. This pelvic movement in turn causes an apparent increase in the vertical diameter of the maternal pelvic inlet, thus offering less resistance to the foetus. Should forced extraction be applied too severely, when for example pulley blocks are used, the cow may be unable to arch her back and the advantageous pelvic tilting may not occur.

To encourage adoption of this posture during the application of traction, Williams (1943) recommended that a 'breech rope' should be passed around the hindquarters of the cow and attached to the manger (or similar fixed object) in front of her. When traction was applied, the hind limbs of the cow would be pushed forward with resultant pelvic tilting. Roberts (1971) noted that the breech bar of some foetal extractors had a similar effect to the breech rope advocated by Williams.

Although traction should ideally only be applied when the cow is herself straining, control of assistants to ensure that traction is so applied, can be difficult in the field. The use of obstetrical pulleys or calf-extractors also has a tendency to apply constant rather than intermittent traction. At best it may only be possible to cease applying further traction rather than stopping traction altogether.

A detailed description of the manner in which traction should be applied to the anteriorly presented foetus was given by Arthur et al. (1982). They recommended that with the rope attached to the foetal head held taut, traction should be applied to one limb in an attempt to advance the shoulder of that limb through the pelvic inlet. The second limb should then be submitted to traction and following this traction should be applied to both limbs and the head simultaneously. One limb should always be maintained in a position slightly in advance of the opposite limb thus ensuring that both of the foetal shoulders were not presented simultaneously at the pelvic inlet. The pattern of traction to each limb and then to the head and the limbs together was repeated, interspersed with further application of lubricant and checking of foetal disposition, until the calf was born.

Special care must be taken during delivery of the foetal head. The position of the cow's vulva renders the dorsal commissure of this structure vulnerable to damage by the bony foetal head during birth (Williams, 1943). Arthur et al. (1982) advised that to prevent damage, the operator should cup his hand over the dorsal surface of the foetal head as it approached the vulva and using the head as a fulcrum, lift the dorsal commissure of the vulva over the foetal head. Care must also be taken to avoid damage to the perineum and Sloss and Dufty (1980) advised that the operator should apply counter pressure to the perineal region, using the palm of his hand, throughout delivery of the head and thorax of the calf. Whenever tearing was threatened they considered episiotomy should be carried out without delay.

Although a number of authors including Benesch (1938) and Williams (1943) have emphasised the need for traction to be carried out slowly, thus allowing ample time for adaptation of the birth canal to foetal passage, there are occasions when delivery cannot be delayed. Possibly the greatest problem confronting the bovine obstetrician is that of adequately assessing the state of oxygenation of the foetus. Monitoring of foetal heart rate and measurement of PO_2 tension of the blood, widely used in human obstetrics, are not normally available in cases of bovine dystocia. The bovine foetus is vulnerable to hypoxia and as Dufty and Sloss (1977) observed in experimental study will not survive interruption of the umbilical circulation beyond a period of six

minutes. Hyperactivity of the foetus, the presence of meconium in the amniotic fluid and evidence of separation of chorioallantois from the endometrium are all indications that delivery should not be delayed. Additional evidence of hypoxia may be an attempt by the foetus to breath in utero (Stockman, 1967; Ward, 1967).

Special care must be taken with the foetus in posterior presentation when compression or rupture of the umbilical cord occurs at an earlier point in delivery than in anterior presentation. Should the foetus in posterior presentation attempt to breath, amniotic fluid may be inhaled into the lungs causing problems in the immediate postpartum period. Benesch (1938) considered that the foetus in posterior presentation should be delivered as rapidly as possible. In the author's opinion however no attempt should be made to deliver the foetus until adequate preparations, including the assembly of sufficient assistance have been made. Once delivery by traction is commenced - with the possibility of interruption of umbilical circulation - it must be completed within a finite time and should therefore not be commenced until the obstetrician considers that the prospects of successful delivery are good.

Rotation of the foetus in posterior presentation through 45° (Benesch, 1938) or through 90° (Schuijt and Ball, 1980) prior to delivery has been suggested to enable full use to be made of the greatest maternal pelvic diameters. Benesch (1938) also advised that during delivery, one foetal limb should be advanced in front of the other thus preventing simultaneous passage of the stifles through the maternal pelvis. In the early stages of delivery traction should be applied in a caudal and slightly dorsal direction, but once both limbs have been delivered traction should be directed ventrally and parallel to the hind limbs of the dam. Despite the special precautions discussed above Benesch advised that the calf should receive immediate attention following birth to ensure that its nasal passages and pharynx were clear of amniotic fluid.

It is generally accepted that if traction, applied over a period of five to ten minutes, is unsuccessful then the case should be reassessed. Presentation, position and posture of the foetus should be checked again and, should any abnormality be detected, it must be corrected before a further attempt at delivery by traction is made.

Wyssman (1934) advised that if obstetrical aid proved unduly slow with the cow in one particular position it was sometimes advantageous for her to be rolled over into another position or placed in dorsal recumbency before further attempts at vaginal delivery were made. In the author's view however, a decision to abandon traction should not be delayed especially when signs of foetal distress are present. Vanderplasse and Spincemaile (1963) reported a high incidence of uterine prolapse in cows which has been subjected to strong traction.

Delivery of the foetus with the aid of a calf-puller should follow the same general principles outlined above for manual delivery. Sloss and Dufty (1980) considered that such machines were not only incapable of applying traction synchronously with the mother's expulsive efforts, but also the direction of traction could not be finely adjusted during delivery. In some models a quick release mechanism is available which allows release of tension in an emergency.

The delivery of a slightly oversized foetus by the author and a final year student using the H-K calving aid is illustrated below (Plates 33-40).

Once the foetus has been successfully delivered, it should be immediately released from the calving ropes or chains and examined to ascertain whether cardiac or respiratory function are intact. Drost (1980b) reminded colleagues of the great physiological challenge that the calf received in the perinatal period and stressed the need to avoid any further adverse influences during the treatment of dystocia. He considered that the calf was capable of breathing as soon as the foetal head passed the vulval lips and recommended that as soon as this happened during assisted delivery, traction should cease and the nostrils should be cleared of mucus and cold water applied to the head to stimulate respiration. Once the calf was born, Drost advised that fluid should be expressed from the nostrils and mouth by external pressure and that the calf should then be suspended by its hind legs to allow drainage of any inhaled fluid.

Should any problem of failure to commence breathing be noted Drost (1980b) advised the following sequence of action:

- 1) Stimulation of respiration - rubbing or tickling the nose and pouring cold water on the head.
- 2) Stimulation of the phrenic nerve - by tapping on the foetal thoracic wall just above and behind the heart.

(Text continues on page 227)

PLATE 33

Foetal delivery using the H-K calving aid (Stage i) Attachment of calving ropes to the foetal forelimbs. The specially designed ropes are knotted for attachment to the hooks on the machine. The operator's left hand encircles the hoof and pushes the calving rope above the fetlock joint. Once in position the rope is tightened by the operator using his right hand. In this case the foetal head was already in the maternal pelvis and a rope was not attached to it.

PLATE 34

Foetal delivery using the H-K calving aid (Stage ii) The ropes have been attached to the hooks on the machine and by manipulating the handle mild tension is applied to the ropes. The breech of the machine is resting against the buttocks of the cow and the free end of the machine is held in a downward direction by an assistant. Milk ejection is occurring from the cow's udder.

PLATE 35

Foetal delivery using the H-K calving aid (Stage iii) As the handle of the machine is moved forwards and backwards, each foetal limb is alternately moved forwards. The operator carries out a vaginal examination to check that the foetal head is moving caudally with the limbs.

PLATE 36

Foetal delivery using the H-K calving aid (Stage iv) With tension maintained on the foetal limbs, the operator eases the dorsal commissure of the vulval lips over the foetal head whilst himself gently applying further traction with the machine. In this case the head has slipped back slightly from its correct relationship with the forelimbs. Whilst good progress has been made, a third rope applied to the head or attached to eye-hooks might have been beneficial.

PLATE 37

Foetal delivery using the H-K calving aid (Stage v) The foetal head has now been delivered. The operator's hand guides the head in a ventral direction whilst at the same time applying counter pressure to the perineum of the dam. The tightness of the ropes suggests that considerable traction is being applied to the calf.

PLATE 38

Foetal delivery using the H-K calving aid (Stage vi) The shoulders of the foetus have been delivered and gravitational forces are assisting birth. The foetus is showing signs of life and the tongue, which was protruding, has been withdrawn into the mouth.

PLATE 39

Foetal delivery using the H-K calving aid (Stage vii) Birth is now almost complete and the foetal hips are about to pass through the vulval lips. The operator is now applying manual traction to the calf as the machine has reached the end of its shaft and can no longer be used to apply traction.

PLATE 40

Foetal delivery using the H-K calving aid (Stage viii) The calf has been released from the calving ropes and was suspended briefly in an upside down position to allow uterine and other fluids to drain out. The cow, which remained standing throughout delivery, is seen licking the calf five minutes after its birth.

(Continued from page 219)

3) Drug therapy - Doxapram HCl, nickethamide or Pentylenetetrazol may be used to encourage the calf to take an initial inspiratory breath. (Note: Respirot (Ciba-Geigy Agrochemicals) which contains crotethamide and cropropamide as active principles has also been recommended in similar circumstances but the author has found it of little value). Arnault (1980) recommended nicergoline as a respiratory stimulant in such circumstances.

4) Forced ventilation - attempts should be made to inflate the lungs but care must be taken to prevent over-inflation. Unless an endotracheal tube is used, inflation of the stomachs and not the lungs may occur.

5) Artificial respiration - the mouth is held open and the tongue pulled forward. Rather than attempting to compress the chest, the chest wall is alternately lifted and then allowed to fall every five seconds. The points for lifting are the upper humerus and the last rib.

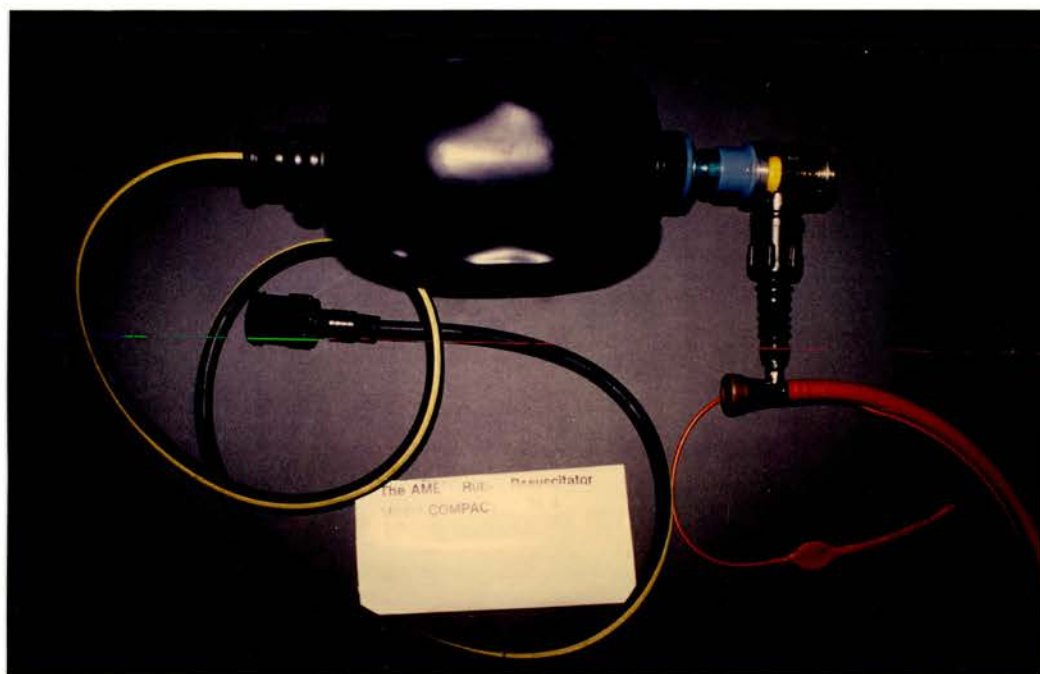
6) Position of the calf - once natural breathing has been established the calf should be placed in sternal recumbency.

7) Acidosis - should this be considered serious and if prolonged, 4-5 g of sodium bicarbonate in 50 ml of water should be given intravenously.

8) Environment - the calf should be maintained in an environment at 15°C at 70 per cent relative humidity while respiration is established.

In some cases great difficulty may be experienced in starting natural respiration even though a good heart beat is present. In such cases the author has found the AMBU bag (illustrated below Plate 41) of value.

PLATE 41



The AMBU bag - a self-inflating device which may be attached to a supply of oxygen and (on compression) drives oxygen or air into the lungs via an endotracheal tube.

The AMBU bag may be connected to a face mask or more satisfactorily to an endotracheal tube. Intubation of the calf may prove difficult but can be carried out with the aid of a laryngoscope. Should this instrument be unavailable the tube may be guided into the trachea via the larynx which is held externally between finger and thumb. The AMBU bag attached to an intubated calf is illustrated below (Plate 42).

PLATE 42



The AMBU bag connected to an intubated calf

It is essential that the foeto-maternal bond is established as soon after birth as possible. Following assisted parturition, especially in primiparous animals, the dam may show little interest in her offspring and indeed may show signs of aggression. In the latter circumstances the calf must be protected from its mother until she is prepared to accept it.

Drost (1980b) recommended that the calf should be given two litres of colostrum immediately after birth.

A brief clinical examination of the calf should be carried out and attention paid to navel hygiene but as soon as possible the cow and her calf should be left quietly alone. Vestre et al. (1978)

noting the occurrence of sub-conjunctival haemorrhage in a calf, advised ophthalmic examination after assisted birth.

Excessive traction may cause serious injury to the dam or her foetus and a number of cases have been described in the literature. Burgon (1934) reported the case of a cow who suffered a fractured pelvis following traction applied by twelve men. The hind end of a calf (a foetal monster) was pulled completely away from the anterior part in a case described by Barlow (1925) in which the damage was caused by a 'local knowall'. Winstanley (1973) advised that should injuries occur to the calf, it should be given immediate and appropriate treatment. He described a case in which the calf had sustained a fracture of the radius and ulna following the traction applied by an unknown number of persons. The case was successfully treated surgically but in another calf in which fracture of the metacarpus had occurred, unsuccessful treatment was followed by amputation.

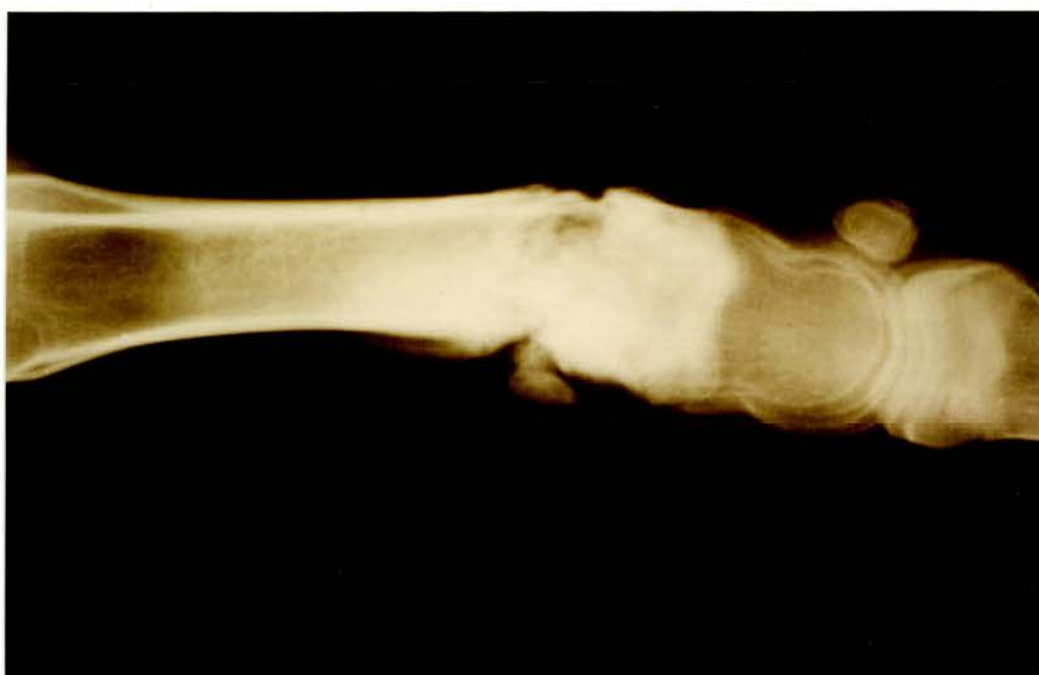
Joint separation and ligament damage were reported in a calf by Coates (1982) which had been pulled from its mother 'with considerable effort'. The problem of displacement of the epiphysis of the femoral head was discussed by Hamilton et al. (1978). Twenty-one of twenty-eight cases recorded were believed to have been caused by excessive traction at birth. The authors recognised a high incidence of the condition in calves of the Charolais, Simmental and Maine-Anjou breeds and their crosses. In some cases 'hip-lock' had occurred during delivery. Seven of the twenty-eight cases had concomitant femoral paralysis with wasting of the quadriceps group of muscles and three calves had also suffered forelimb injury. The authors suggested that routine radiological examination of the hips should be carried out on all calves of the above-mentioned breeds which had been delivered by assisted birth. Such routine screening would, they believed, allow early diagnosis, treatment and possibly improved prognosis in cases where surgical treatment might be undertaken.

Internal damage, especially to the central nervous system, may also occur during assisted birth. Haughey (1975) found evidence of meningeal haemorrhage and congestion in a series of eight calves which had been born following assisted birth. The lesions were found at single or multiple sites and were believed to be caused by hypoxia or trauma. Similar lesions were also found in ten of sixteen calves

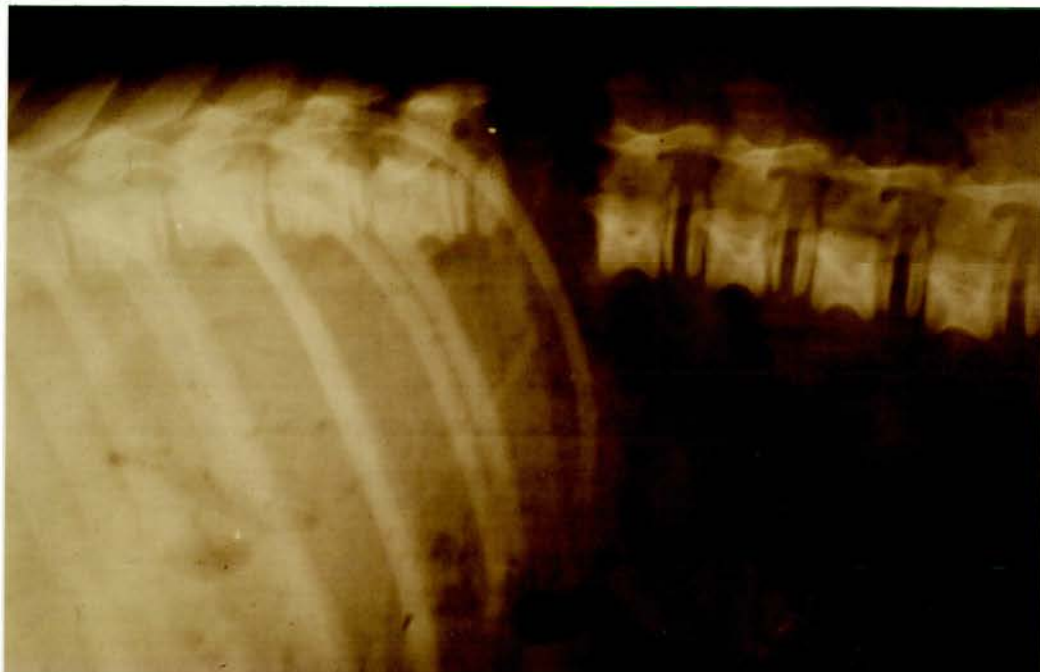
in which delivery had been unassisted. Other injuries found at post-mortem by Haughey included fractured ribs, separation of the costochondral junction, ruptured livers and haemorrhage into the hip joints and inter-vertebral spaces. Goedebuure et al. (1979) considered that not all such injuries were caused by traction and believed that some might be caused by intense muscular contraction in the hypoxic calf.

Illustrated below are examples of foetal injury caused by excessive traction at birth (Plates 43 to 46).

PLATE 43



Injury caused by excessive traction - fracture of the metacarpus.
Radiograph lateral view.

PLATE 44

Injury caused by excessive traction - fracture and separation of spine.
Radiograph lateral view.

PLATE 45

Injury caused by excessive traction - slipped epiphysis of femoral head.
Radiograph dorso-ventral view.

PLATE 46

Injury caused by excessive traction - femoral paralysis in Charolais calf. Note - there was no radiographic evidence of hip damage in this calf.

CHAPTER FIFTEEN

EMBRYOTOMY

The term 'embryotomy' is used to describe the technique of foetal division, within the vagina or uterus, into portions which may be more easily delivered through the birth canal. Roberts (1971), Bierschwal and de Bois (1972) and Sloss and Dufty (1980) were among authors who preferred to describe the technique as 'foetotomy'. Since the period of the bovine embryo is considered to end at the 45th day of gestation the term 'foetotomy' is undoubtedly more accurate. In Britain however the term 'embryotomy' is long established and is also in current usage (Arthur et al., 1982).

Embryotomy may be either (a) total - when the entire foetal body is subjected to progressive division or (b) partial - when the removal of a small portion of the foetus may allow delivery of the remainder. Two main methods of embryotomy have been described, (a) subcutaneous or intra-foetal in which portions of the foetus are dissected out through incisions made in the skin or (b) percutaneous or extra-foetal in which a sawing device is employed to cut off the foetal parts which are to be removed.

In a review of the history of embryotomy Bierschwal and de Bois (1972) noted that there was evidence that the technique had probably been practised in some form since 400 B.C. Harward (1673) described the use of a 'stumpy knife' to divide a foetus in utero but it was not until the 18th and 19th centuries that the technique of subcutaneous embryotomy became both well developed and sophisticated. One of the first reports of subcutaneous embryotomy in the British literature was that of Hayes (1833), a Rochdale practitioner, who described removal of a foetal forelimb in a case of dystocia caused by foetal oversize.

The subcutaneous technique was undoubtedly taxing upon the strength of the operator and Gray (1877) expressed the belief that 'there must be a better way if man could only think of it'. He continued prophetically 'I am convinced that we can contrive instruments that would lessen the manual labour and mortality attending difficult cases of parturition. I think an instrument can be devised capable of disjuncting any part

of the foetus and also a knife capable of cutting through the muscle of shoulder or thigh with facility and safety'.

No mention of the technique of percutaneous embryotomy was made by Fleming (1877) and the development of the embryotomy wire by van Staa in Holland (Hendrickx, 1903) was of major importance in establishing the procedure as a viable alternative to the older subcutaneous method. A number of tubed embryotomes were manufactured and were designed to carry the flexible wire. Many were described and illustrated by Benesch (1938). The development of epidural anaesthesia for obstetrical operations by Benesch in 1926 enabled embryotomy to be carried out in greater safety and undoubtedly encouraged the increasing popularity of the technique (Bierschwal and de Bois, 1972).

Surveys of obstetrical methods in the treatment of bovine dystocia in Switzerland and Germany by Enzler (1958) and by Aehnelt et al. (1971) respectively, recorded the rising popularity of embryotomy especially in the late 19th century and the early part of the 20th century. They also noted the declining use of embryotomy which followed the establishment of flank caesarean section under local anaesthesia.

In both Britain and the United States of America embryotomy never achieved the popularity which attended the technique on the continent of Europe. Tutt (1944) considered that minor procedures of partial embryotomy were often attended by success but that total embryotomy was somewhat hazardous. In America Roberts (1971) commented upon the reluctance of many practitioners to embark on major embryotomy whilst Arthur et al. (1982) observed that caesarean section enjoyed a much greater popularity even in the case of a dead foetus.

In certain parts of Europe tuition in the techniques of embryotomy still occupies an important place in the student time-table. At Utrecht Veterinary School approximately 500 neonatal calves are purchased annually and following euthanasia, are subjected to embryotomy in phantom uteri as illustrated below (Plate 47). In addition 200 pregnant cows are purchased annually (de Bois, personal communication) and when second stage labour is observed to commence, the foetus is destroyed in utero and subjected to total embryotomy by a group of students. Illustrated below (Plate 48) is such a student group performing embryotomy under supervision and observed by the author during a recent visit to Utrecht.

PLATE 47



Phantom uterus used for embryotomy tuition at Utrecht Veterinary School

PLATE 48



A group of Dutch veterinary students performing embryotomy at Utrecht Veterinary School

The economics and indeed the ethics of this type of tuition are debatable but Dutch veterinarians are expected by their clients to be competent and experienced in the technique of embryotomy at the time of qualification (van Dobbenberg, personal communication). Embryotomy was performed on 200 of 1300 cows admitted in one year to the Utrecht clinic for the treatment of dystocia (Bierschwal and de Bois, 1972).

Relatively little practical tuition in the techniques of embryotomy is given to British veterinary students and this may well contribute to the disinclination of British veterinarians to use the procedure in practice. Williams (1943), noting that embryotomy might be 'disagreeable and taxing' to both patient and operator, believed that the obstetrician wishing to achieve competence in the techniques involved should supplement 'thorough study with extensive practical experience'. The importance of skill had earlier been emphasised by Benesch (1938) who considered that it was essential that the ability of the operator was sufficient to allow completion of any procedure undertaken. Further details of tuition in embryotomy have been given by Anon. (1904), Nowag (1926) and Boyd (1951).

In their series of 200 cases of bovine dystocia, Morten and Cox (1968) used embryotomy in only five per cent of cases whilst Sloss and Johnston (1967) working in Australia employed the technique in eight per cent of their cases. In a later series of cases involving parturition in 2480 cows Sloss (1974a) found that embryotomy was necessary in 16.6 per cent of cases - a figure influenced by a high incidence of dead and emphysematous calves.

Comparing the techniques of subcutaneous and percutaneous embryotomy, Benesch (1938) considered the latter to be less time-consuming but requiring expensive equipment. There might also be a greater risk of maternal damage with the percutaneous technique as a result of perforation or laceration of the birth canal during the use of instruments. Sloss and Dufty (1980) reported that they found subcutaneous embryotomy a valuable procedure especially in cases in which putrid emphysema of the foetus had occurred. Specific indications included:- (a) impaction of an emphysematous or oedematous foetus so tightly in the birth canal that it was impossible to introduce instruments for percutaneous embryotomy, (b) an impacted breech presentation and (c) cases in which one foetal fore-limb was presented at the vulva with

the other fore-limb and the foetal head retained within the uterus.

Percutaneous embryotomy was indicated in cases of foetal over-size, faulty foetal disposition and in foetal monsters, especially conjoined twins. The technique was faster, less arduous to perform and more adaptable than the subcutaneous method. Modern embryotomes enabled incisions to be made through the foetus in any plane but their use was accompanied by a greater incidence of instrument-induced damage to the birth canal.

Most veterinarians would probably agree with Schuijt and Ball (1980) that embryotomy should normally only be considered in cases of dystocia in which the foetus is already dead. Similar sentiments had been expressed by both Fleming (1877) and by Benesch (1938) although the latter author gave instructions concerning methods of foetal destruction prior to embryotomy should the necessity arise. In anterior presentation the foetal carotid might be severed, the thorax punctured or the brain penetrated by passing a metal rod through the naso-pharynx. Destruction of the foetus in posterior presentation could be accomplished by cutting the umbilical cord. The value of calves and aesthetic considerations would nowadays prohibit foetal destruction except in exceptional circumstances.

Numerous examples of the use of partial or complete, intra-foetal or extra-foetal embryotomy are to be found in the literature. The largest number of cases involved the treatment of dystocia caused by foetal monsters and of these, conjoined twins were the largest category and were described by Meginnis (1851), Hall (1889), McAleer (1899), Dawson (1903b), Fafin (1907), Beckett (1926), Hogben (1928), Hughes (1930), Chinniah (1952) and Krueger (1954). Watson (1871), Moffett (1902) and Harmar (1943) described the use of embryotomy in the resolution of dystocia caused by *Schistosomus reflexus* whilst Murray (1951), Donald et al. (1952) and Blood (1956) recorded the use of the technique in 'outbreaks' of foetal ankylosis, dropsy and arthrogryposis respectively.

Faulty foetal disposition was another important indication for embryotomy and its use in the treatment of difficult cases of breech presentation was described by Younghusband (1854b), Metherell (1883), Davis (1924b), Edwards (1924a and b), Farrell (1968) and Borsberry (1974). Edwards described the interesting technique of 'femoral

embryotomy' in which he dissected down to the femoral head and severed the teres ligament. He then applied traction to the femoral head, pulling the hind limb out from within its covering of skin. Cases of lateral deviation of the foetal head requiring embryotomy were described by Canu (1838), Parker (1915a), Goldsmith (1930) and Herr (1979). A calf in ventral position was delivered following embryotomy by Drouard (1842), whilst Miller (1863) used a pocket knife to divide a foetus in transverse presentation. Pouchy (1841) and Struck (1934) both reported their use of embryotomy to deliver oversized fetuses associated with prolonged gestation.

Cox (1877a and b) and de Bruin (1903) advised the use of embryotomy in cases of dystocia caused by foetal emphysema whilst Findlay (1897) described the application of the technique to a case which he encountered in practice. In cases of dystocia caused by constriction of the birth canal embryotomy may only be feasible if it is possible to pass instruments or the operator's hand past the obstruction. Successful treatment of soft tissue obstruction cases was described by Collett (1922), Scott (1930) and Allen-Potts (1941) whilst a case of bony tissue obstruction in which embryotomy was employed was reported by Anon. (1902).

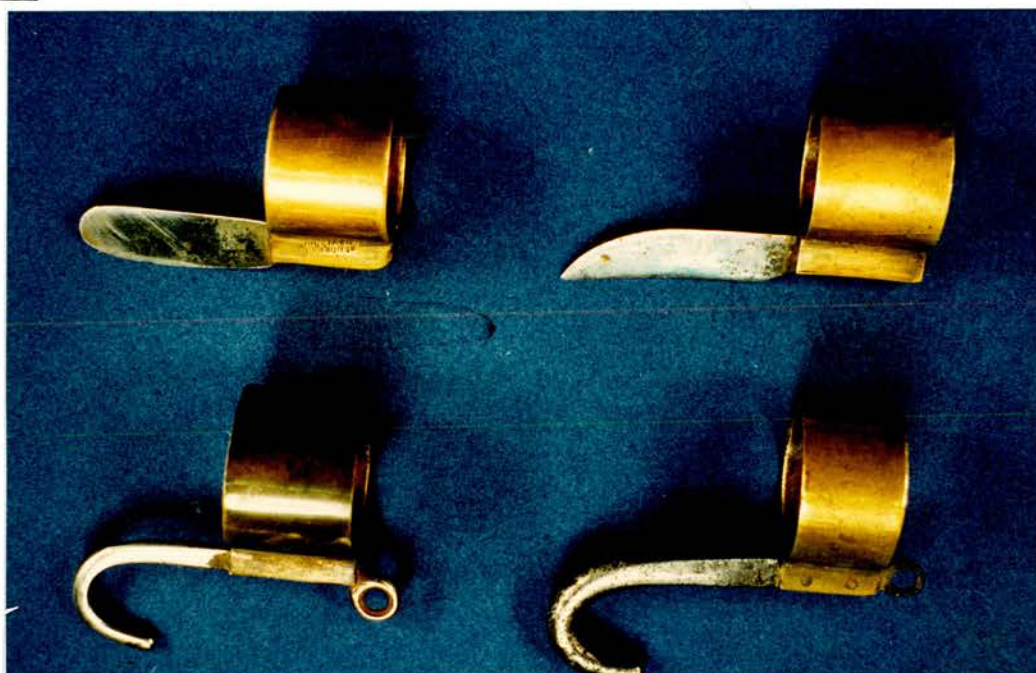
Detailed descriptions of all the operative methods employed in subcutaneous and percutaneous embryotomy are beyond the scope of this thesis. Benesch (1938), Roberts (1971), Sloss and Dufty (1980) and Arthur et al. (1982) have all provided detailed instructions for the performance of the most important operations and reference will be made herein to one or two techniques only during the description of some of the instruments employed.

Undoubtedly embryotomy is most easily performed upon the standing cow under the influence of epidural anaesthetic with adequate help and satisfactory restraint of the patient. Sloss and Dufty (1980) reported that the French obstetrician Michelat had suggested that a satisfactory alternative to epidural anaesthetic was to place the cow in sternal recumbency with her legs pulled out behind her. This posture prevented straining but in the author's view might also increase intra-abdominal pressure and possibly worsen working conditions.

The term 'embryotome' was used by early writers including Fleming (1877) to describe any cutting instrument employed during embryotomy.

Among some of the earliest embryotomes were the small finger knives illustrated with finger hooks below (Plate 49). Used principally to cut through the skin and divide the foetal muscles in subcutaneous

PLATE 49



Finger knives and hooks used in the performance of embryotomy

embryotomy, the knives were worn upon the first finger. They were carried into the birth canal with the blade shielded by the operator's thumb and middle finger. The blade of the knife might be straight or curved (Fleming, 1877). Copeman (1843) wrote that he wore the finger knife in such a way that it was concealed by his crooked finger. Cartwright (1845b) reported that although he found finger knives most useful there were cases in which he could make no progress and which he had 'to abandon and leave to nature'. Specially designed knives were not always available and Toll (1860) reported the successful division of a *Schistosomus reflexus* monster with the aid of a pocket knife only.

Despite careful use, knives with exposed blades presented a serious hazard to both patient and operator and a number of knives with concealed or retractable blades were devised. Three are illustrated below (Plate 50).

The knife at the top of the illustration was described by Fleming as 'Colin's scalpel embryotome' and was fitted with a blade guard which could be moved back to expose the cutting edge when it was needed. A very similar device had been described by Thibaudeau (1831) whilst

PLATE 50



Embryotomy knives with concealed blades - from above Colin's scalpel, Unsworth's knife and Robert's knife.

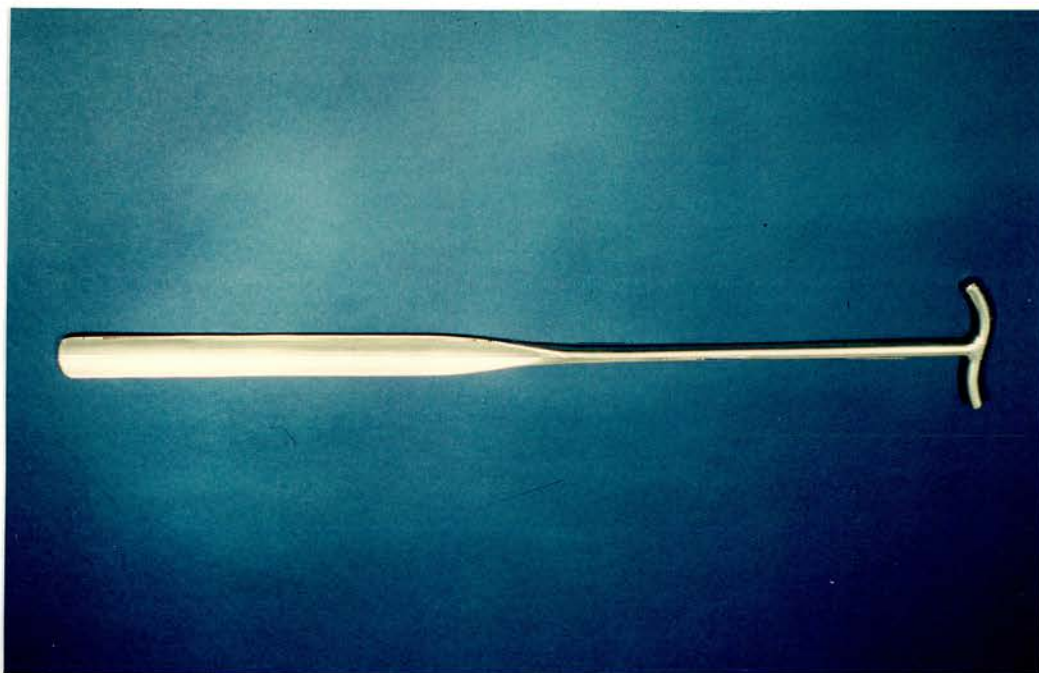
Nelson (1847 and 1849) described, but did not illustrate, a knife with a retractable blade which he had invented 'some years ago'. Unsworth's knife (Unsworth, 1890) had a blade held in a retracted position by a spring but which could be exposed by single-handed pressure by the operator. A similar knife had previously been described and illustrated by Cole (1883a and b).

Robert's knife (Anon., 1919a) was devised by a Tunbridge Wells practitioner who also invented many other instruments including drills for hoof surgery and whelping forceps. The knife was later described in detail by Benesch (1938) and is still in use at the present time. The end of the blade was flattened into a duck-billed shape which was inserted under the foetal skin through a small incision. Once in position, the knife was advanced, severing tissues passing between the blade and its guard. Benesch (1938) reported that the entire operation of subcutaneous removal of a foetal fore-limb could be performed with the aid of Robert's knife. A small incision was made over the lateral aspect of the fetlock joint and extended up towards

the shoulder using Robert's knife. The limb was held in extension using a calving rope applied just below the fetlock joint. Using the fingers the operator separated the foetal skin from the subcutaneous tissues of the fore-limb. The muscular attachments of the limb to the thorax were broken down either manually or with the aid of Robert's knife. Following disarticulation of the fetlock joint, traction was applied to the distal end of the metacarpus and with a twisting action the limb was pulled from under the skin. The digit of the limb, still attached to the skin, was a useful point of traction.

Dissection of the skin from underlying structures - particularly joints where it is more firmly attached - was sometimes aided by the use of a spatula, an example of which is illustrated below (Plate 51).

PLATE 51



Spatula used in subcutaneous embryotomy

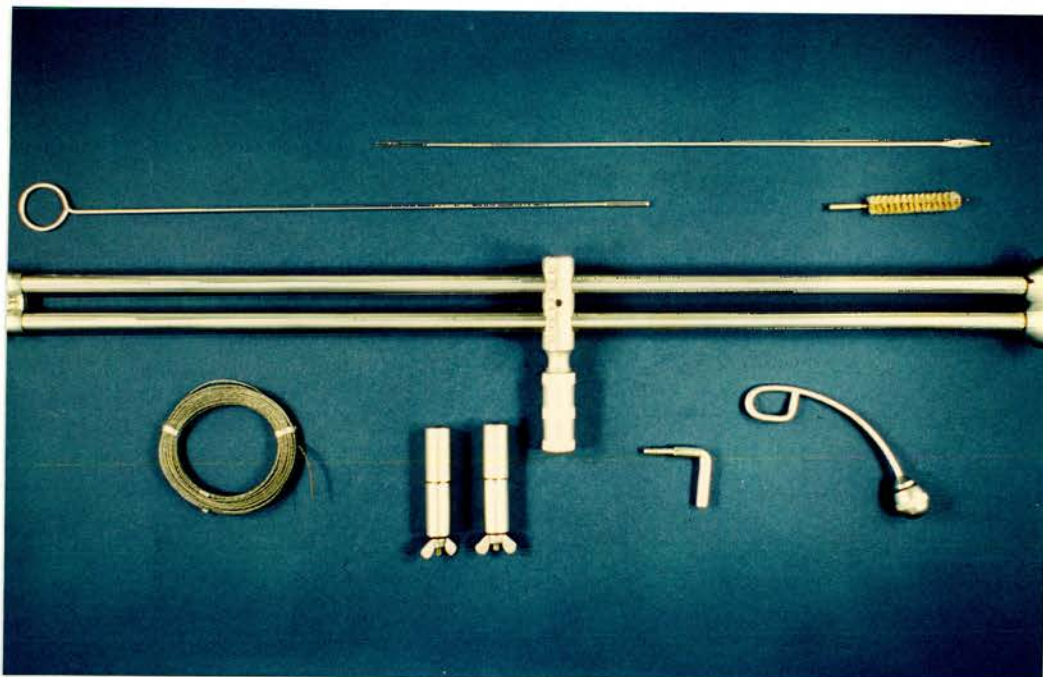
Pflanz (1905) advised that air should be forced under the foetal skin, using a cycle pump, to facilitate elevation of skin from underlying tissues. He also illustrated an ingenious device (somewhat similar to a modern calf-puller) with which the separated limb could be more easily pulled out from its covering of skin.

The lack of safe and easily used sawing instruments was a serious disadvantage to obstetricians in the early part of the 19th century. Cartwright (1842a) considered that a pair of strong shears would be most useful in severing the lower portions of the hind-limbs of a foetus in breech presentation. In one of his later contributions to the literature (Cartwright, 1861b) he stressed the need for a small saw which could be safely used within the uterus.

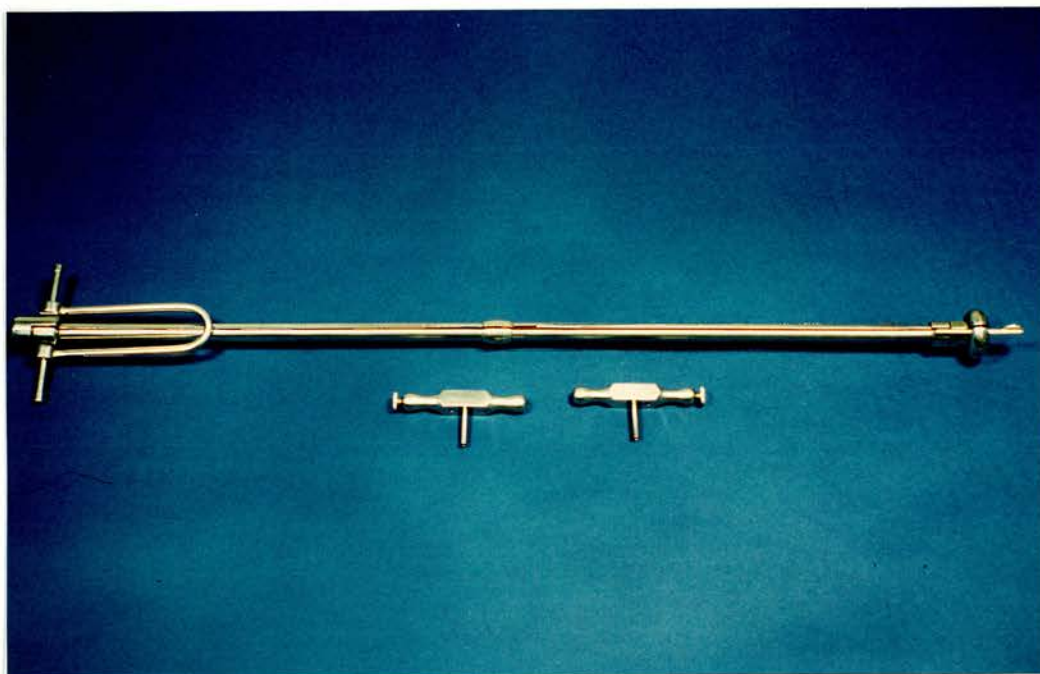
A chain saw of unknown manufacture was illustrated by Gilani (1891) and Fincher (1931) described the successful use of Persson's chain saw in the division of a *Perosomus elumbis* foetal monster. Fincher believed the saw had been introduced to the profession in 1875 and whilst it had been widely used in Scandinavia it had not found favour in his native America. Gibbons (1934) reported the use of what he termed 'Pearson's chain saw' to divide the pelvis of an over-sized foetus. The development of the obstetrical chain saw was an important event which enabled the obstetrician to encircle and sever a foetal part in comparative safety. Having only one cutting edge, however, the chain saw could only cut in one plane and had a tendency to become stuck when being used to cut through bone (Benesch, 1938).

The importance of van Staa's invention of the embryotomy wire has already been mentioned and it was followed by the production of many different models of tubed embryotomes. One of the most popular was that designed by the Danish veterinarian Thygesen in 1921 which is illustrated in its modified modern form below (Plate 52). The original model of Thygesen's embryotome is preserved in the museum of the Copenhagen Veterinary School (Rasbech, personal communication). Lagerlöf (1951) was a great protagonist of Thygesen's embryotome noting 'it has served us well for thirty years'.

Single tube embryotomes were also available, one such being the Mose embryotome illustrated below (Plate 53). Such instruments were less satisfactory than those possessing two tubes (Edwards, 1930c) and were inclined to become clogged up with foetal debris, a problem exacerbated by the movement of two strands of wire in opposite directions within the tube. This embryotome is no longer manufactured and indeed in Britain the Thygesen embryotome is the only model available from many instrument suppliers.

PLATE 52

Thygesen's Embryotome - also illustrated is a loop of embryotomy wire with handles, a wire threader, an introducer, a key to tighten the adjustable handle and a cleaning brush.

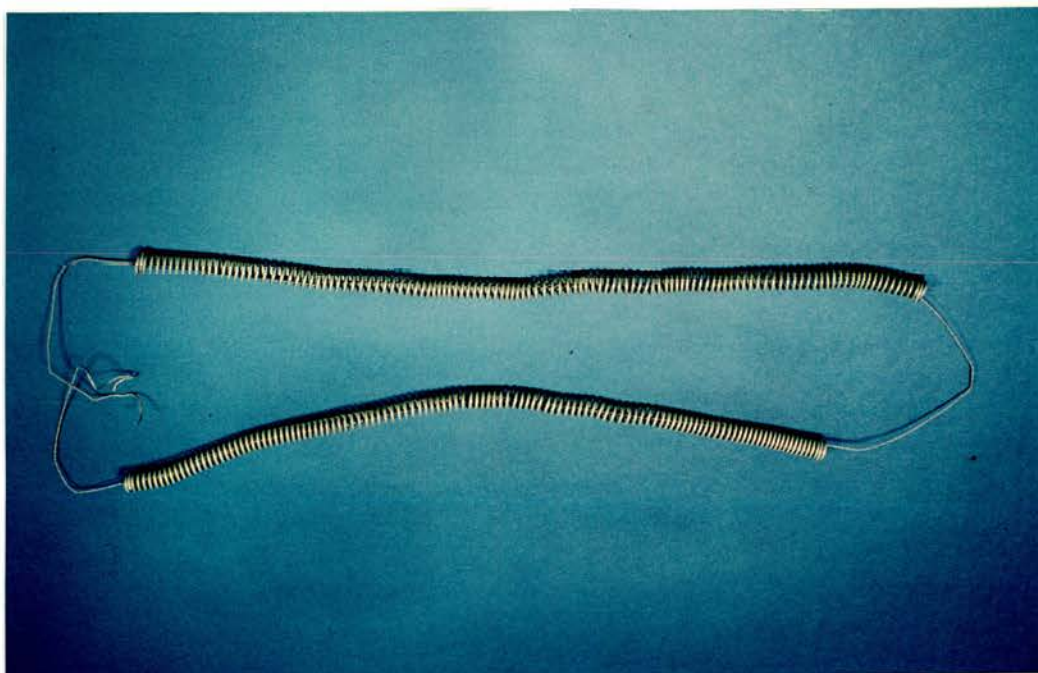
PLATE 53

The single-tubed Mose embryotome - also illustrated are handles for attachment to the embryotomy wire.

Brooksbank (1932) considered that it was permissible for embryotomy wire to be used without being enclosed within the tube of an embryotome, provided that the ends of the wire were crossed over each other after encircling the foetal part to be severed. Such a procedure would however tend to be hazardous and in an emergency some protection might be given to the birth canal of the dam by enclosing the wire within rubber hosepipe tubing.

Glattli's spiral tubes (illustrated below, Plate 54) were a simple and inexpensive device designed to enclose the embryotomy wire as it traversed the birth canal. The tubes could be held in position by the operator's hand or might be held in a specially designed metal head (Bahkle, 1934).

PLATE 54



Glattli's spiral embryotomy tubes

Illustrated below is the Provost embryotome (Plate 55) which was capable of crushing and hence dividing tissues including bone by means of a stout wire hawser tightened mechanically. Although not illustrated in obstetrical texts, the instrument was described by Burke (1940) who used it to divide the pelvis of a calf in breech

PLATE 55The Provost Embryotome

presentation. Edgar and Kennedy (1970), reporting upon thirty years experience with their Provost embryotomes also found the instrument especially useful for pelvic bisection. In another account of its use, Buie (personal communication) reported that he found the instrument satisfactory for removal of a foetal head or limb within the uterus. The embryotome was however somewhat difficult to use and required an assistant to hold it in position and operate the handle which tightened the wire hawser. Buie also noted that the heavy duty wire was difficult to handle and became frayed with use.

In cases in which embryotomy is required to remove a foetal head or limb in normal presentation from within the birth canal, the wire of the threaded embryotome may be passed over the part in question and tightened ready for sawing to commence. The operator periodically checks that satisfactory progress is made, taking great care to avoid damage to his own fingers. Considerable effort may be required to hold the embryotome in a fixed position during the sawing process and some authors including Sloss and Dufty (1980) attached the instrument to the foetus by means of calving ropes or chains. An assistant is

required to manipulate the wire saw and once the foetal skin has been penetrated - a process which may be aided by making an initial incision with an embryotomy knife - division of the foetal parts is quite rapid.

In cases of lateral deviation of the foetal head, flexion of the fore-limb at the shoulder and breech presentation, it is not normally possible to loop the threaded embryotomy wire over the appendage to be removed. In such cases the embryotomy wire must be passed around the foetal part before being threaded through the tubes of the embryotome. A similar technique is required to place the embryotomy wire in position for pelvic bisection. The use of an introducer to which the light flexible wire is attached is of great value. Any heavy and rounded object may be used, but a number of specially designed introducers are available. Illustrated below are Shriever's and Lang's introducers (Plate 56).

PLATE 56



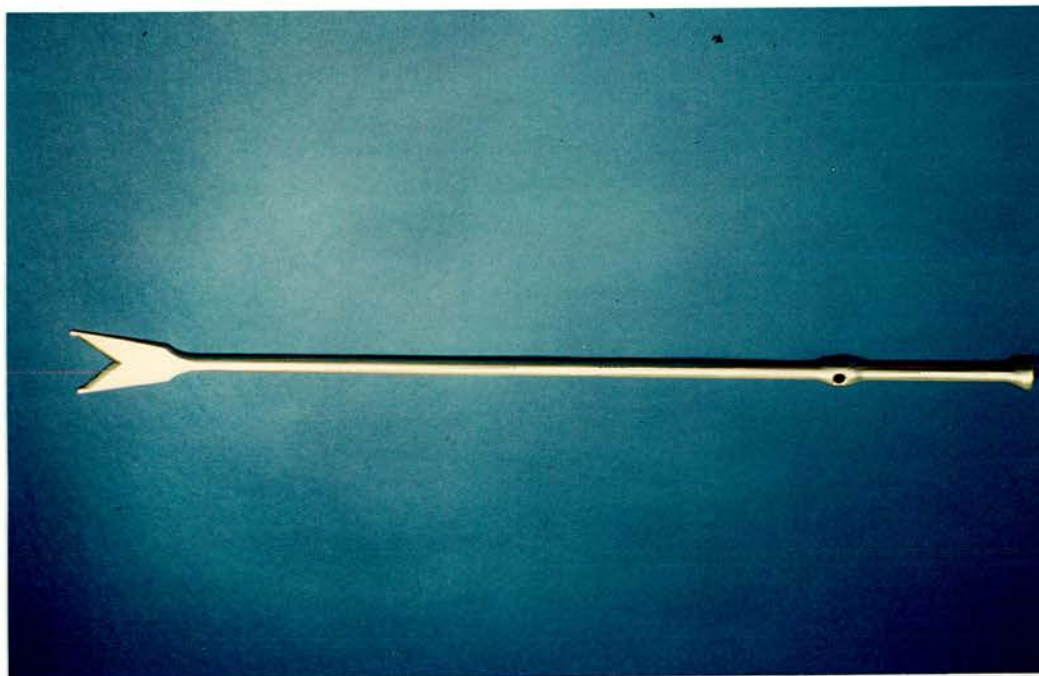
Introducers for embryotomy wire - Shriever's introducer above, Lang's introducer below.

A particularly useful introducer was Pollock's porte-band spring. Made in various sizes the instrument consisted of a flattened flexible steel band with circular metal loops at either end for attachment of either embryotomy wire or calving ropes. The author found this particular introducer of exceptional value when placing the embryotomy wire prior to pelvic bisection. Unfortunately these porte-bands are no longer available. Pollock (1898), a Norfolk practitioner, was an extremely able inventor of instruments including an obstetrical guillotine and a harpoon. The latter device could, it was claimed, be thrust into the head of a foetus whereupon it would 'fly open' fixing itself firmly and becoming an anchor to which traction might be applied. Not all Pollock's contemporaries were impressed by his plethora of instruments and one (Maynard, 1898) wrote somewhat sceptically 'it is one thing to teach but another thing to use all these instruments'.

Other complicated sets of instruments were described by Walker (1886), Anon. (1893) and by Gooch (1898a and b). Walker's instruments included an embryotomy knife, the blade of which could be extruded by the application of pressure upon the handle. When the blade was retracted the instrument could be used as a spatula. Gooch's instruments were equally ingenious and included 'Gooch's external screw embryotome and hooks'. The interchangeable guillotine-like blades and the self-tightening hooks were attached to the end of a 27 inch long metal handle. The knife blades were closed by rotating the handle outside the vagina of the cow and traction was applied when, it was claimed, that those portions of the foetus enclosed between the knife's jaws were easily severed.

An obstetrical chisel (illustrated below - Plate 57) may also be used during embryotomy but Sloss and Dufty (1980) considered the instrument to be dangerous and difficult to control. These authors did, however, illustrate the chisel in their text book, together with a wooden baton with which to strike the instrument, for use in the operation of pelvic symphysiotomy in heifers.

Benesch (1938) illustrated and described an interesting instrument which was termed 'The Becker-Schöttler Vakufakt'. Its use, together with long harpoon-shaped hooks, was recommended for the performance of embryotomy upon the oversized foetus in anterior presentation. The

PLATE 57Obstetrical Chisel

instrument was designed to saw around the vertebral column allowing it to be removed, with the probable aim of reducing the size of the foetus and enabling it to be manipulated with greater ease. During a recent visit to Europe the author saw examples of this instrument preserved, but no longer used, in the museums of the veterinary schools at Ghent and Hannover.

Following the operation of embryotomy the cow should be carefully examined for signs of injury caused during foetal delivery. Good nursing including antibiotic cover should be provided as detailed in Chapter Seventeen of this thesis. Provided care has been taken and the cow was in good condition at the time of embryotomy the prognosis should be quite good. Vanderplassche et al. (1953), in a review of 239 cases, recorded a maternal death rate of ten per cent with retained placenta in thirteen per cent of cases. Eighty per cent of cows had conceived again within ten months of embryotomy.

CHAPTER SIXTEEN

CAESAREAN SECTION

The date when bovine caesarean section was first performed has been a matter for some speculation. Fleming (1877) considered that the first authenticated accounts of the operation in the European literature were published in 1813 and 1816. Crowshey (1636) however provided his readers with detailed instructions as to how the operation should be performed. His phraseology suggested that he was speaking from personal experience. He wrote 'ascertain on which side the calf is lying, clip away the hair between the thighs and ribs and make a vertical incision through the skin. A hand anointeth with new milk is then introduced, the uterus is brought out and the foetus is removed. The placenta is then removed and the uterus sewn up with silk'.

One of the earliest reports of bovine caesarean section in the British literature was that of Carlisle (1840). Called to a case of uterine torsion, he performed a mid-line laparotomy to remove the calf. Post-operatively the cow's abdomen was supported by a canvas bandage and roller. Unfortunately the patient died overnight and damage was found postmortem, possibly resulting from the original torsion, just anterior to the cervix. Carlisle's account prompted Youatt (1840) to enquire through the columns of the *Veterinarian* whether any other colleagues in practice had performed caesarean section.

Two previous accounts had in fact already been published. In one (Anon., 1832) the account was entitled 'Horrible barbarity by a country cow leech' and gave a brief description of the removal of a dead foetus by laparotomy following unsuccessful attempts to deliver the calf per vaginam. The cow died later. The anonymous author suggested that his unqualified colleague should be punished for his 'temerity'. Berry (1834) reported how, in the absence of a local veterinarian, a friend (possibly medically qualified) had removed a foetus from the abdomen of a heifer which suffered uterine rupture. Success was apparently not anticipated as Berry concluded 'the heifer died as expected'.

Following Youatt's request for more information, Hayes (1840)

reported that he had performed caesarean section on seven occasions, the first in 1824. Three of his cases had survived and in two of the fatal cases, death had resulted from peritonitis. Horsburgh (1840), a Dalkeith practitioner, had performed the operation on one occasion without success. He wrote 'I fear you will hear of few successful cases - it is never performed until all other means that are commonly tried have failed and the animal is totally exhausted'. Horsburgh considered as did Bonnet (1848) that vaginal hysterotomy was a far more satisfactory operation than caesarean section in cases in which adequate cervical dilation had not occurred. Williams (1887), the Principal of the New Edinburgh Veterinary College, did not share this view believing caesarean section to be more satisfactory.

In a lengthy paper devoted to various aspects of parturition, Crundall (1848) gave a detailed description of caesarean section performed through a right flank laparotomy. It is doubtful whether he wrote from practical experience and he appeared to have little enthusiasm for the operation. He wrote 'I opine that humanity would rather dictate that the animal should be destroyed as I cannot imagine that such a formidable operation would be attended with success. It is revealed that where the operation has been attempted, it almost invariably terminates fatally'. Cartwright (1851) who was always at the forefront of contemporary veterinary obstetrics believed that the operation should be attempted more frequently (and not as a last resort) in many forms of dystocia. He advised careful preparation of the patient including the administration of an aperient and catheterisation of the bladder.

A not infrequent indication for caesarean section in cattle was the imminent death of the cow. Younghusband (1851) described such a case in which he destroyed the cow by injecting air into the jugular vein before delivering the living calf by laparotomy. MacGillivray (1884) operated on two cows, suffering from severe nasal haemorrhage and from tuberculosis respectively, shortly before their deaths. He did not believe in either stunning the unfortunate animals or administering morphine analgesia since he believed that such action would increase the likelihood of foetal death.

Although anaesthesia was not at that time a legal requirement for surgery Fleming (1877) advised that 'humane feelings should ever

be predominant' and anaesthesia using chloral hydrate, chloroform or ether should be used subject to availability. Undoubtedly much suffering did occur and may, with the poor results obtained following surgery, have contributed to the unpopularity of caesarean section in the late 19th century and early 20th century.

Fleming considered that caesarean section in large animals was one of the longest, most fatiguing and most difficult operations that the veterinarian might be called upon to perform. He summed up current (1877) attitudes to the operation thus 'There is no doubt that the great mortality which follows the operation is due to the conditions under which it is undertaken. It is, as a rule, never resorted to until all other means of delivering the animal have failed and the creature, worn out by suffering, is already almost dead'. Many other authors of the period shared this view and either made no mention at all of caesarean section as a method of resolving dystocia or doubted its value (Dalrymple, 1898; de Bruin, 1901; Taylor, 1903; Williams, 1917; Williams and Frost, 1919).

An editorial in the Veterinary Record (Anon., 1939) postulated that 'the operation was commonly performed in this country much earlier than is generally supposed, even before the 1914-1918 war'. Some practitioners, the editorial believed, accepted caesarean section as routine but unfortunately did not communicate their findings to the literature with the result that colleagues elsewhere continued to regard the operation as being constantly attended by a poor prognosis.

With this lack of publicity, many veterinary surgeons were naturally influenced by their own limited experience. Edwards (1925) considered the value of caesarean section as being 'negligible' whilst Bell (1936) observed that he might be tempted to perform the operation 'for curiosity rather for hope of success'. Having attempted the operation once, upon a case of dystocia caused by foetal oversize, Bell concluded 'the possibility of success under farmyard conditions is remote'. Edwards (1930b) had expressed similar views but Götze (1929a) who reported good results operating under epidural anaesthesia at Hannover believed that caesarean section was of great value, sparing the strength of both the cow and her helpers.

The use of local anaesthesia and antibacterial agents undoubtedly enhanced the prognosis of caesarean section and authors began to report

successful series of cases (Roberts and Frank, 1942; Gendreau, 1944). Williams (1943) was however still somewhat reluctant to recommend the operation and considered that the results of surgery had not been comprehensively studied. He advised that veterinarians should select their cases carefully and discuss the prognosis with the cow's owner before proceeding.

Caesarean section became progressively more popular as a treatment for dystocia from 1950 onwards (McLintock, 1953; Enzler, 1958; Aehnelt et al., 1971). An earlier protagonist for the operation had been Straiton (1945) who later admitted that he had perhaps been over-enthusiastic in the application of what he termed 'this practice building procedure'.

Arthur et al. (1982) considered that caesarean section was accepted as a routine procedure in cattle practice and was increasingly preferred to total embryotomy per vaginam in cases in which either technique might be adopted. Schuijt (1977) considered that farmers might demand the operation when it was not strictly necessary.

Indications for Caesarean Section

Whilst most categories of bovine dystocia may on occasion require treatment by caesarean section, Arthur et al. (1982) listed five main indications which they considered accounted for over 90 per cent of the operations performed in practice:-

- a) Foetal oversize
- b) Incomplete dilation of the cervix
- c) Irreducible uterine torsion
- d) Foetal deformity
- e) Faulty foetal disposition.

Alternative procedures to caesarean section might be available in cases of foetal oversize, deformity or faulty disposition but in the case of failure of the cervix to dilate or irreducible uterine torsion the operation was, these authors believed, 'almost obligatory'. In reviewing the indications for caesarean section Sloss and Dufty (1980) included an elective operation in cases where severe periparturient disease in the dam necessitated immediate removal of the foetus.

Numerous accounts of the general indications for caesarean section have appeared in the literature and include surveys by:- Sutton (1947), Vanderplassche and Paredis (1953), Wright (1953), Arnold and Usenik (1957), Walker (1957), Balazs et al. (1968), Roberts (1971), Herak (1974) and Parkinson (1974). Gendreau (1944) reported that he used caesarean section whenever he considered the cow's life was in danger as a result of the dystocia from which she was suffering whilst Straiton (1945) considered an important indication was to avoid 'barbarous traction'. Schuijt and Ball (1980) regarded caesarean section as the logical sequel to failed attempts to deliver a living foetus by traction and the author of this thesis believes that most practitioners would share this view.

It is interesting to note that Fleming (1877), whilst listing many of the indications mentioned above, did not include foetal over-size which was seldom a problem at that time. Roberts and Frank (1942), Williams (1967 and 1968) and Carnegie et al. (1974) all reported that they found obstruction of the birth canal caused by an immature maternal pelvis an important indication for caesarean section. Other specific indications for caesarean section mentioned in the literature include the following:-

 Foetal monsters - Carbury (1924a), Smythe (1941), Hartley and Wanner (1974) and Donnelly et al. (1975)

 Prolonged gestation (with, in some cases, foetal oversize) - Williams (1954), Williams (1956), Johnson and Haxby (1955), Jones (1964) and Callaghan et al. (1969)

 Double muscling of the foetus - Ménissier (1980)

 Fracture of the maternal pelvis - Muir (1946b)

 Recto-vaginal obstruction in Jersey cattle - Leipold et al. (1981)

 Rupture of the uterus - Wheat (1948), Georgi (1954), Prather (1954) and Botcherby (1980)

In an interesting report Assmusu and Frerking (1971) described successful caesarean section in a cow in which traumatic reticulitis and generalised peritonitis had been diagnosed. They considered that the operation should always be contemplated when in similar circumstances the cow was seriously ill, the foetus was alive and the possibility of vaginal delivery and cow survival were doubtful.

Prognosis

The development of reliable and safe methods of sedation, anaesthesia and surgery together with the experience of good results over the past thirty years have established caesarean section in cattle as a procedure which should be accompanied by a reasonable prognosis.

Roberts and Frank (1942) commenting on their experiences with a series of 58 caesarean sections believed the best results were achieved with cattle which:- (a) had been in labour for less than 18 hours, (b) had suffered minimum damage to the vagina and uterus through attempts at manipulative delivery, (c) were in good condition at the time of surgery and (d) completed third stage labour within twelve hours of surgery. These authors also believed that good after-care of the patient was essential to ensure that the survival rate was as high as possible. Of the cases which they considered to be good surgical risks, 78 per cent survived with a calf survival rate of 47 per cent. Aehnelt et al. (1968) considered that the duration of pregnancy at the time of surgery, the time of rupture of the foetal membranes, the duration and severity of extraction efforts and the viability of the calf were all factors which were likely to affect the outcome.

Gendreau (1944), Gould (1951), Wright (1953) and Arnold and Usenik (1957) were among authors who reported that maternal recovery rate was highest among cows presented for surgery as early as possible after the commencement of labour. In 'fresh' cases Christiansen (1967) recorded a maternal survival rate of 94 per cent with 67 per cent calf survival. In protracted cases of dystocia presented for surgery the survival rate of cows and calves was 85 per cent and three per cent respectively. Working with beef cattle in Australia, Sloss (1974a) reported that 85 per cent of cows survived caesarean section when presented early in labour, a figure which fell to 62 per cent in neglected cases. Reporting on an early series of cases, some of which were operated on under general anaesthetic, Wright (1953) recorded an overall maternal survival rate of 62 per cent. This figure fell to 52 per cent in cases in which the calf was already dead when the case was presented for surgery. Arthur et al. (1982) noted

that 88 per cent maternal survival had been achieved in a series of 1064 caesarean sections at Bristol Veterinary School despite the fact that the foetus was dead at the time of surgery in 37 per cent of cases.

A number of authors have attempted to compare the prognosis of caesarean section with other methods of delivery. Vanderplassche and Paredis (1953) reported that both milk production and subsequent fertility were poorer after caesarean section than following embryotomy. Debackere et al. (1959) however, who compared the results of 340 caesarean sections with 80 embryotomies, reported that the overall maternal recovery and subsequent fertility were approximately the same for both techniques. They found that in cases of dystocia caused by foetal oversize, the maternal death rate was higher following embryotomy than caesarean section.

Aehnelt et al. (1971) compared calf survival following caesarean section and following delivery by traction. 89 per cent of calves survived the former technique and 66 per cent the latter. Detailed case histories were not given and it is possible that the results may have been influenced by the fact that the technique of caesarean section was chosen in a greater number of cases in which the calf was known to be alive.

A study by Heil (1978) compared the development of calves born by caesarean section (at the time of slaughter) from cows at day 263-272 of gestation with that of calves born naturally at term. He found that those calves born by caesarean section were both slower to gain their feet after birth and had a poorer post-natal growth rate. For these reasons he advised that in the field the stage of gestation of a cow should be carefully checked before the performance of elective caesarean section. Since service dates are often not known the exact stage of gestation may not be known although an estimate may be made.

The prognosis of caesarean section is also influenced by the skill of the operator and by the availability of clean and hygienic surroundings. Judge (1956) considered that poor results must be expected if adequate assistant help was not available.

Despite the exercise of skill and care at the time of surgery, even under optimum conditions, a proportion of cows subjected to

caesarean section do not make a good recovery. Cooper (personal communication) questioned the success of the operation especially in dairy cows in which he believed the incidence of post-operative subclinical problems was quite high. He also considered that calf survival beyond the immediate post-partum period might not be as high as was generally believed. Arthur et al. (1982) warned that a proportion of cows survived surgery but remained unthrifty and infertile. They considered that such animals might suffer from chronic peritonitis and perimetritis and show signs of intermittent pyrexia which failed to respond to treatment.

Restraint

Whenever possible caesarean section should be performed in a clean, well-lighted area with good restraint and adequate help. Unfortunately, under field conditions, the cow may be recumbent and surgery must be undertaken in less than ideal surroundings.

In the standing animal the head must be restrained and some facility must be available to prevent the hind end of the cow from swinging round onto the operator and causing injury by crushing or kicking. A number of simple operating pens have been designed and greatly facilitate caesarean section in the standing cow. Illustrated below are two such pens seen by the author during a recent visit to Europe (Jackson, unpublished data) (Plates 58 and 59).

In the standing animal, there is always a risk that the cow may suddenly lie down during surgery causing considerable difficulty to the operator (Aehnelt et al., 1968; Walker and Vaughan, 1980). In an attempt to prevent the cow lying down on the side of her laparotomy wound, Sloss and Dufty (1980) advised tying the fetlock of the opposite hind limb to the head collar or halter. Fleming (1877) advocated that surgery should be performed on the recumbent cow and considered that to operate upon the standing animal was both difficult and dangerous. Modern methods of sedation have rendered standing surgery less hazardous, although it can still cause difficulty in heifers unaccustomed to handling.

When surgery is performed on the recumbent animal the use of a tipping table may be useful (Rasbech, 1957). Parkinson (1952) reported

PLATE 58

Restraining pen for bovine caesarean section. University of Liège
Veterinary School, Brussels.

PLATE 59

Cow, awaiting caesarean section, standing in a simple adjustable pen
at the Royal Agricultural and Veterinary University, Copenhagen.

that he found surgery on the recumbent cow much less fatiguing than on the standing animal although he later reported that he preferred the standing operation (Parkinson, 1973 and 1974). Straub and Kendrick (1965) and Johnston and Sloss (1967) were among many authors who expressed general preference for the standing operation. Whether or not the operation is performed on the standing or recumbent animal depends greatly upon the form of anaesthesia used and upon the site of surgical incision and both these considerations will be discussed in greater detail below.

Anaesthesia

The Protection of Animals Act of 1919 was regarded by some practitioners as being anomalous in that although rumenotomy might legally be formed under local anaesthesia other laparotomy procedures, including caesarean section, might only be carried out under general anaesthesia (Anon., 1930b; Pillers, 1930). Chloral hydrate was one of the most popular agents used and was given either orally or per rectum (Fleming, 1877; Gray, 1937; Parkinson, 1952) or by intravenous injection (Carbury, 1924a; Straiton, 1945; Gould, 1951). The drug, which was believed to have a depressant effect upon the unborn foetus, might be supplemented by local anaesthesia (Wright, 1953) or given in combination with chloroform (Muir, 1946b). General anaesthesia using chloroform alone was also employed (Curtis, 1937 and 1939b; Sutton, 1947) but both this agent and chloral hydrate were liable to produce unacceptable fatalities in the patient.

The passing of the Protection of Animals (Anaesthetics) Act of 1954 enabled British veterinarians to perform caesarean section under local anaesthesia (Messervy et al., 1956). Epidural, local infiltration and paravertebral techniques were all permissible. Epidural anaesthesia, both low and high sacral (Götze, 1929a and b), might be used either alone (Frank, 1940) or in combination with local infiltration anaesthesia (Rasbech, 1957; Walker and Vaughan, 1980). High segmental spinal anaesthesia, described by Arthur (1956a), was found to be effective but liable to produce pain at the time of administration. Care must be taken to avoid over-dosing with epidural anaesthetic since the animal may lose the ability to stand, and should be carefully restrained during recovery.

Local infiltration anaesthesia at the site of operation was recommended by Johansen (1969) and is a popular technique with British practitioners. It may be given in the form of an L-block and also used in conjunction with xylazine sedation (Herak, 1974; Fraser and Herchen, 1978). Sloss and Dufty (1977) noted that local infiltration anaesthesia, unlike the paravertebral technique, often failed to produce adequate peritoneal anaesthesia. Paravertebral anaesthesia, in which the thirteenth thoracic nerve and the first two lumbar nerves are blocked close to their exit from the spinal cord, has become a popular method of anaesthesia for caesarean section. Some hyperaemia and a greater tendency to haemorrhage may be observed on the side of the animal which has been anaesthetised (Arthur et al., 1982).

Xylazine has been shown to be of great value in producing sedation in even the most fractious of cattle. The drug does however have a tendency to increase the tone of the uterine musculature making intra-abdominal manipulation of the uterus difficult. Sloss and Dufty (1977) advocated the administration of a smooth muscle relaxant - menthindizate - to counteract the effects of xylazine. Alternatively isoxsuprine lactate may be used (Ahlers and Andresen, 1967; Aehnelt et al., 1971; Horvath and Bacsfay, 1978) and has been found greatly to facilitate exteriorisation of the uterus from the operation wound.

Should general anaesthesia be required heavy sedation may be produced using xylazine and following intubation, halothane may be administered.

The Site of Surgical Incision

Considerable discussion has taken place concerning the most satisfactory site of incision for caesarean section in cattle. The choice of site is dependent upon many factors and each possible site has its own advantages and disadvantages (Milne, 1952; Arnold and Usenik, 1957; Roberts, 1971; Noorsdy, 1979). Chaffaux (1980) observed that individual practitioners often had very rigid ideas concerning their 'favourite' site for incision but like Noorsdy (1979) he considered that each case should be carefully assessed before a decision was made concerning the most favourable site. Noorsdy

advised that before selecting the incision site the patient should be submitted to a vaginal, rectal and general clinical examination. If the cow was able to stand and able to remain standing he considered that the flank approach had much to recommend it. The availability of anaesthetic agents and the size of the foetus were also important considerations. If facilities for heavy sedation or general anaesthesia were not available, ventral abdominal sites were precluded. Should the foetus be very large or dead, the ventral sites provided excellent access to the uterus. The vascularity of the ventral abdomen in high yielding dairy cows might cause problems with haemorrhage should a site in this region be chosen for surgery.

Noorsdy considered the left flank site was generally the most advantageous but on occasion, gross ruminal distension might be a problem. The mid-line ventral abdominal approach had the advantage of a hidden post-operative scar but was associated with a greater risk of wound breakdown. High or low flank incisions might be used and although an incision high in the flank was liable to less post-operative oedema, it could present the operator with difficulties in raising the uterus and then extracting the foetus.

A review of the literature has suggested that caesarean section through a left flank laparotomy incision is probably the most widely recommended and was used by:- Anon. (1950), Parkinson (1952), Messery et al. (1956), Straub and Kendrick (1965), Frerking et al. (1967), Balazs et al. (1968), Aehnelt et al. (1971), Sloss and Duffy (1977) and Arthur et al. (1982). The right flank was chosen or recommended by:- Carbury (1924a), Smythe (1941 and 1944), Williams (1943), Gendreau (1944), Gould (1951) and Fraser and Herchen (1978).

Incision sites in the ventral or ventro-lateral abdominal walls appeared to be less well favoured for the reasons discussed by Noorsdy (1979), namely the need for general anaesthesia, the poor healing and risk of prolapse associated with these sites. Mid-line laparotomy was however recommended by Jasper (1950), McLintock (1953) and Johansen (1969). Faull and Brewitt (1961) reported an unfortunate sequel to a mid-line caesarean section performed to deliver an oversized foetus. Twenty-four hours post-operatively, wound breakdown occurred followed by intestinal prolapse. Further surgery including enterectomy was required and adequate healing eventually occurred.

It is interesting to note that the original surgery was performed under sedation and local infiltration anaesthesia only and much straining occurred during and after the operation. Walker and Vaughan (1980) advised that cattle weighing over 1,000 lbs were not good subjects for mid-line caesarean section, being especially liable to wound breakdown.

A paramedian approach, medial to the milk vein, was favoured by Blendiger (1939), Frank (1940), Roberts and Frank (1942) and Wright (1953). An incision lateral to the milk vein was used by Vanderplassche and Paredis (1953) and by Rasbech (1957).

A ventro-lateral approach to the uterus was described by Oehme (1967), a technique which Noorsdy (1979) considered had 'much to recommend it'. The exact site of incision was below and parallel to the fold in the flank and just above the lateral border of the udder. The incision was made parallel to the border of the ribs on a line drawn between the cow's umbilicus and stifle. Oehme considered that this site provided good access to the uterus and that there was less risk of post-operative breakdown than in the more ventral sites close to the mid-line. Muscle closure could be difficult at the time of surgery and post-operative oedema readily collected.

Surgical Technique

Detailed accounts of the surgical technique required for caesarean section have been given in the text books of Roberts (1971), Sloss and Dufty (1980) and Arthur et al. (1982) and by a number of authors including Parkinson (1973 and 1974). Numerous other authors have offered advice concerning various aspects of the operation.

The emergency nature of caesarean section normally precludes much pre-operative preparation of the patient (Messervy et al., 1956). Straub and Kendrick (1965) advised that whenever possible pre-operative starvation should be practised in an attempt to reduce the size of the rumen. In cases in which this was not possible they believed that rumenotomy might occasionally be necessary before embarking upon caesarean section.

A normal supply of instruments for laparotomy is required for caesarean section, but Ross (1945) reported that he had successfully performed the operation on a Scottish hillside armed with only a scalpel, scissors, suture material, iodine and cotton wool.

Strict attention must be paid to asepsis but Johansen (1969) believed that what he termed 'veterinary school asepsis' could not

be maintained under field conditions. In the latter conditions, Johnston and Sloss (1967) and Sloss and Dufty (1980) considered that an antiseptic rather than an aseptic technique might be a more attainable goal with the operator frequently dipping his hands into an antiseptic solution during the operation. Gould (1951), Straub and Kendrick (1965) and Johansen (1969) all advised that the operator should wear two pairs of surgical gloves at the beginning of the operation and discard the outer pair after the foetus had been removed - thus allowing the sterile inner pair to cover the hands during closure of the wounds etc.

The initial incision into the abdomen is made in the usual way and an incision 25 cm in length is normally adequate to allow delivery of the average foetus (Sloss and Dufty, 1980). Once the abdomen is open, the pregnant horn of the uterus is brought to the laparotomy wound. Götze (1929a) advised that a fold of uterine wall might be grasped to achieve uterine movement but most authors have favoured the technique of grasping a foetal limb through the uterine wall. Vanderplassche (1963) found that the pregnant uterus might be brought to the laparotomy wound more easily in the recumbent than in the standing cow. In neglected cases it may be extremely difficult to bring the uterus, which has contracted tightly down upon the foetus, to the laparotomy wound where it can be opened. Vanderplassche (1963) advised extending the laparotomy wound in such circumstances, whilst Parkinson (1973 and 1974) recommended encircling the uterus with a calving rope and using this to lift the uterus to a more accessible position. The author of this thesis has encountered cases in which the uterus has been totally immobile and in such cases the operator may have to open the uterus deep in the abdomen with the risk of damaging other organs. Cox (1981a) observed that since the pregnant uterus and its contents might weigh up to 200 Kg movement of the uterus would normally be difficult. In his experience it would normally only be possible to bring a foetal appendage near to the abdominal wound in elective caesarean sections and in those cases operated on in early second stage labour. In the cases in which he could not exteriorise the uterus he found Robert's embryotomy knife very useful for making a 'blind incision' into the uterus. Pearson (1982) considered that repeated attempts to bring the uterus to the

abdominal wound might be contraindicated and recommended that it should be opened within the abdomen.

A generous wound should be made in the pregnant horn to allow the foetus to be removed without tearing the uterine wall (Messervy et al., 1956) and when possible the cotyledons should be avoided to lessen the risk of haemorrhage (Sutton, 1947). Care must also be taken to avoid cutting the foetus at the time the uterus is opened and Sloss and Dufty (1977) advised making the incision in the uterine wall overlying the space between a pair of foetal claws to lessen the risk of injury. Sutton (1947) advised that the surgeon should avoid spilling uterine fluid into the peritoneal cavity but Arnold and Usenik (1957) and Arthur et al. (1982) believed that such spillage was unimportant unless the uterus was grossly contaminated at the time of surgery.

Removal of the foetus from the uterus may require careful manipulation to align its long axis with the uterine wound and prevent damage to the uterus. Gendreau (1944) observed that it was less difficult to remove the foetus in posterior presentation to the wound than in anterior presentation since in the former only two extremities had to be manipulated. Special difficulties may occur with abnormal foetuses and Gould (1951) noted that it might be necessary to make multiple incisions into the body of an emphysematous foetus, in an attempt to reduce its size, before it could be removed from the uterus. Arthur et al. (1982) observed that embryotomy might be needed to reduce foetal size (especially in the case of foetal monsters) in preparation for removal through the restricted length of the uterine wound.

Following foetal delivery, the uterus must be searched for the presence of a second foetus (Messervy et al., 1956) and for signs of damage accidentally inflicted during surgery. Fleming (1877) recommended that the uterus be swabbed out following foetal removal. Padmanabhan (1925), having given similar advice, advised that a towel be passed from the uterus and out through the vagina to 'clean the vaginal cavity'. Before proceeding to uterine closure, the surgeon should siphon off excess uterine fluids and insert antibiotic pessaries. No attempt is normally made to remove the placenta unless it has become detached from the uterine wall (Arthur et al., 1982).

It is interesting to note that Gendreau (1944) recommended manual extirpation of the corpus luteum 'to encourage passage of the placenta'. The placenta is normally passed within twenty-four hours of surgery.

If the uterus is healthy, rapid involution follows foetal removal and for this reason, unless suturing is commenced promptly, it may be difficult to gain access to the most caudal part of the uterine wound. Fleming (1877) questioned the necessity of suturing the uterus in view of its rapid involution but it is normally closed with one or two layers of inversion sutures. Two layers of silk sutures were used by Smythe (1941 and 1944) and by Balazs et al. (1968) but more recently polyglycolic acid sutures have been employed and may provoke less uterine inflammation and improve post-operative fertility (Arthur et al., 1982). Saline lavage of the uterus and the intraperitoneal administration of dexamethasone may reduce the risk of post-operative adhesions (Sloss and Duffy, 1980).

Repair of the laparotomy wound is based on normal surgical principles although a number of special observations have been made in relation to caesarean section. Blendiger (1939) advised that the peritoneum should be included with the muscle sutures and Sloss and Duffy (1980) found a much higher incidence of post-operative sub-cutaneous emphysema if the peritoneum was not carefully sutured.

In the recumbent cow closure - especially of low abdominal wounds - may be difficult (Vanderplassche, 1963) especially if rumenal tympany has developed. Various techniques of laparotomy wound closure have been recommended. Messervy et al. (1956) described the 'Bristol method' in which six heavy duty sutures were used, each penetrating the entire thickness of the abdominal wall. Careful tying of sutures is most important and Walker and Vaughan (1980) reported that loosening of suture knots was the most common cause of wound breakdown following caesarean section in cattle. Metal skin clamps are widely used in Europe and a report by Frerking et al. (1967) noted that uncomplicated wound healing occurred in 97 per cent of cases in which clamps were used compared with 85 per cent of cases in which traditional suture material was used. Aehnelt et al. (1971) found metal clamps used to close the skin were quick to apply, did not penetrate the skin and greatly reduced the risk of post-operative infection.

During a recent visit to Copenhagen the author was able to observe a well-organised modus operandi for caesarean section. At the veterinary school some 200 bovine caesarean sections are performed annually by small groups of students (Rasbech, personal communication). The restraining pen used has already been described (see Plate 59 above). Anaesthesia was induced using a multi-dose syringe to apply local infiltration analgesia - see Plate 60 below:

PLATE 60



Caesarean Section at Copenhagen Veterinary School - Induction of local anaesthesia.

Following routine preparation of the left flank, a sheet of sterile plastic material was glued around the operation site and then a section over the site was removed. Under supervision the students carried out left flank caesarean section (see Plates 61 and 62 below). Unfortunately the author was unable to record the final stages of surgery owing to a camera fault. The peritoneum and muscle layers were repaired using chromic cat gut and the skin wound was sealed by metal clips.

PLATE 61

Caesarean Section at Copenhagen Veterinary School - retrieval and opening of pregnant uterus.

PLATE 62

Caesarean Section at Copenhagen Veterinary School - removal of the foetus in posterior presentation by traction applied via chains to the hind limbs.

Management of the calf following delivery by caesarean section

Once the foetus has been removed from the uterus it should be handed over to an assistant for care and if necessary for resuscitation while the surgeon completes the operation (Parkinson, 1974). Johansen (1969), working in the South Dakota prairies, advised that before the umbilical cord was severed any blood within it should be 'milked' back towards the foetus thus avoiding any unnecessary blood loss. He also advised routine application of a face mask, ventilated with air or oxygen, to the nose and muzzle of the calf in an attempt to support respiration. Thurmon and Benson (1981) considered that more active treatment of post-delivery apnoea might be achieved by intubating the foetus before delivery. They advised that the foetal head be brought to the laparotomy wound, the calf intubated with the aid of a laryngoscope and suction applied to remove excess fluids from the lungs and bronchial tree. Once the calf is delivered, positive pressure ventilation is applied to aid the establishment of natural respiration.

Umbilical hygiene following delivery by caesarean section is as important as following manual delivery. Arthur et al. (1982) advised that the umbilical cord should not be ligated following operative delivery and reported some evidence that the procedure might increase the incidence of inflammation in the cord.

Post-operative care of the dam

The degree of post-operative care required following caesarean section may be influenced to a certain extent by the state of the cow and foetus when presented for surgery and upon the degree of asepsis employed. Any complications, such as uterine laceration or any difficulty during surgery may necessitate more intensive care. Undoubtedly the use of antibacterial drugs including the sulphonamides greatly reduced the incidence of post-operative infection and adhesions (James, 1941; Sutton, 1947; Sloss and Dufty, 1977). Gould (1951) recommended a daily health check and injection of penicillin for three days after the operation whilst Messervy et al. (1956) advised a five-day course of antibiotics. Sloss and Dufty (1980) however considered that the routine use of antibiotics was only justified if the foetus was dead or decomposing. The author believes that the

strategic use of antibiotic injections and tetanus antitoxin can be of great value in preventing post-operative difficulties.

Working in India before the discovery of antibiotics, Padmanabhan (1925) reported that he found the feeding of rice congee and carbolic acid of value in reducing the incidence of post-operative infection.

Routine post-operative use of ecbolics has been advised by many authors including Sutton (1947) and is of value in promoting rapid involution of the uterus and completion of third stage labour. More intensive drug therapy including the administration of saline drips, dextrose and calcium may be necessary in some cows (Roberts and Frank, 1942; Balazs et al., 1968). In an area where flies were a problem Johansen (1969) reported that he applied fly repellants to the surgical wound after the operation. As most of his cases were among semi-wild range cattle he found it of great value to return cow and calf to the herd as soon as possible after surgery in an attempt to reduce stress.

Repeated intra-uterine therapy is not normally required except in cases in which severe infection is present. In such cases intense parenteral and intra-uterine antibiotic therapy may be helpful. McWilliam (1954) reported that he found chlorhexidine of value as a uterine lavage in cases in which metritis was suspected.

Careful nursing and supervision are required during the post-operative period and owners should be instructed to seek professional help should any problems arise. Wound breakdown is dealt with according to surgical principals and subcutaneous emphysema, a common sequel to caesarean section normally disperses without treatment within three weeks of surgery. Aehnelt et al. (1968) proposed a schedule of post-operative care which it is unlikely the practitioner could emulate. They advised that each cow be examined at ten, 40 and 80 days post-operatively for signs of health and that on each occasion a rectal examination should be performed to check for the development of adhesions.

Post-operative complications

The most common post-operative complications following caesarean section are puerperal sepsis, local wound infection, the development

of seromata and adhesions, peritonitis and subcutaneous emphysema (Roberts and Frank, 1942; Sutton, 1947; Anon., 1950; Wright, 1953; Debackere et al., 1959; Aehnelt et al., 1968 and Balazs et al., 1968).

Although Parkinson (1952) considered that complications of caesarean section were rare, a detailed study by Sloss and Dufty (1977) of the results of elective caesarean section in 56 heifers revealed that some complication occurred in up to 51 per cent of cases. The main problems encountered in this survey were:-

<u>Lesion</u>	<u>Heifers affected (%)</u>
Adhesions (detected by rectal examination)	51
Subcutaneous emphysema *	41
Generalised fatal peritonitis	5
Retained placenta	30

(* as mentioned above the incidence of emphysema fell when careful suturing of the peritoneum had been carried out.)

Post-operative fertility

Although numerous examples of successful conception following caesarean section have been reported in the literature, doubts about fertility at one time contributed to a reluctance to use the technique more widely. Gray (1937) had reported conception following caesarean section to remove a decomposed foetus from a ruptured uterus whilst Straiton (1945) claimed excellent milk production and fertility following surgery in the majority of cases. Laue (1949) reported operating upon a cow by candlelight which had been in labour for three days and which later conceived, whilst Turnbull (1951) reported conception after caesarean section to deliver a mummified foetus. Nye (1949, 1950 and 1951) however considered that a cow was unable to breed in the same uterine horn from which a foetus had been removed surgically. He actually advised ipse-lateral ovariectomy at the time of caesarean section to encourage future conception in the contra-lateral uterine horn. Nye, perhaps logically, concluded that no cow could therefore undergo more than two caesarean operations and yet remain fertile. In response to this claim Milne (1951) produced evidence of a cow which was known to have undergone the operation on three occasions. Later Noorsdy (1964) reported that two cows had

conceived and carried their calves to full term having each undergone caesarean section (albeit pre-term) on five occasions. In Belgium, where double-muscled calves are deliberately bred, cows regularly undergo caesarean section on four or five occasions (Ectors, personal communication).

That successful conception can occur following caesarean section is now well established and numerous surveys have confirmed this view including those of Wright (1953), Messervy et al. (1956), Lanz (1958), Vanderplassche (1963), Morten and Cox (1968) and Aehnelt et al. (1971).

Mention was made at the beginning of this chapter of some of the comparisons which have been made between fertility following caesarean section and embryotomy. Vanderplassche and Paredis (1953) and later Aehnelt et al. (1971) both reported better conception rates following embryotomy than following caesarean section. Debackere et al. (1959) had however reported little difference between the two techniques. Christiansen (1963) warned that such comparative surveys should be interpreted with care and pointed out that many cows which had undergone surgery were never presented for service. His own survey of fertility following caesarean section suggested that the nature of the original dystocia might be important. In his survey of 308 caesarean sections subsequent breeding data were available in 50 per cent of cases. Approximately one half of the cases were cows which had suffered prolonged dystocia prior to surgery. Only 25 per cent of these animals were presented for service and of these only 25 per cent conceived. Much better conception rates were observed in those cows which had not suffered protracted dystocia. 49 per cent were presented for service and 66 per cent of these conceived.

CHAPTER SEVENTEEN

AFTER-CARE OF THE DAM

The responsibilities of the obstetrician do not cease with the delivery of the calf. The cow must be examined to ensure that no further foetus remains in the uterus and that no damage has been sustained during foetal delivery. Roberts (1971) pointed out how embarrassing it would be for the veterinarian to be called back to a case to deliver a second foetus which he had failed to detect whilst dealing with the first. Early detection and treatment of injury is essential and Beynon (1976) believed that such early action might reduce the number of cows culled annually as a result of calving injuries.

Fortunately the cow is seldom found in the pitiful state following assisted delivery as was described by Fleming (1877). Noting that in 'trifling' cases little postparturient care was necessary he observed 'in the majority of cases the animal is much prostrated from prolonged suffering and straining. So much so indeed as to be extended in a comatose condition or apparently dead from nervous exhaustion'. In such severely depressed animals Fleming considered that it was essential to make the mother comfortable and to restore her strength. He advised that the cow's body should be rubbed down and covered with warm clothing. Warm gruel and tepid water should be given as a drench and pain could be relieved by the administration of morphia either as a drench or by enema.

Arthur et al. (1982) considered that the incidence of post-parturient disease was likely to be much higher in cases which had been the victim of lay interference or of delay in sending for professional help. Sloss (1974a) observed that 21.3 per cent of cows might suffer some degree of damage at assisted delivery and noted that there was a higher incidence of injury among beef cows than among dairy cows. Hudson (1980) warned that when damage was sustained it was likely to be of a multiple nature and stressed the need for a very thorough post-parturient examination to ensure that nothing was overlooked. Wynne (1900) considered that evidence of prolonged post-parturient pain was

a particularly ominous sign and that its cause should be investigated without delay. Biochemical evidence of prolonged and difficult calving might be found in elevated maternal blood levels of lactic and pyruvic acid (Sevcik and Kacmaric, 1975).

In the author's opinion the cow should be encouraged to regain her feet as soon as possible after delivery of the calf. Not only will the act of rising lessen intra-abdominal pressure (thus facilitating internal examination and reducing the risk of uterine prolapse) but it also appears to encourage the cow to take an interest in her calf. In general the longer the delay before the cow attempts to regain her feet after calving the more difficult the act of rising becomes.

As soon as possible after foetal delivery the birth canal should be submitted to a careful and methodical internal examination. Such examination may be facilitated by epidural anaesthesia (Caldwell, 1933a). Strict attention to hygiene at this time is extremely important and following foetal delivery there is a tendency for vigilance to be relaxed. Bostedt et al. (1979) demonstrated that even after normal birth a considerable bacterial flora was present within the birth canal. The bacterial count of many organisms including *E. coli*, *Proteus vulgaris* and *Staphylococcus aureus* was much higher in animals which had suffered dystocia than those which had given birth unaided.

A study by Luginbühl and Küpfer (1980) reported similar findings but observed that the bacterial content of the genital tract decreased more quickly after difficult birth than after normal birth. Arthur et al. (1982) warned that when the vagina had been subjected to contusion there was a high risk of infection by anaerobic organisms. According to these authors the massive contamination of the birth canal by opportunist pathogens which followed assisted parturition was normally rapidly dealt with by the cow's own defence mechanisms - antibody response and the re-establishment of the vaginal seal preventing further influx of organisms. Failure of uterine involution following foetal delivery, possibly predisposed by uterine inertia, might according to Sloss and Dufty (1980) result in retention of foetal fluids with the provision of an ideal bacterial culture medium within the uterus. Roberts (1971), Drost (1980a), Sloss and Dufty (1980) and Arthur et al. (1982) were among authors who advised the administration

of ecbotic injections to any animal in which postparturient involution of the uterus appeared to be delayed. At one time the use of 'cleansing drinks' especially those containing ergot was recommended (Dickinson, 1925).

As an aid to the prevention of infection many veterinarians routinely administer an antibiotic injection after foetal delivery. It is essential that to be effective a full course of antibiotics should be given (Bostedt et al., 1979). Every effort must be made to prevent the development of acute metritis which can be a life-threatening problem in cattle. In areas where tetanus is known to occur, routine prophylaxis with antitoxin should be given. Jochle and Hildago (1967) advised the routine use of corticosteroids in cattle which had suffered dystocia and considered that these substances enhanced the recovery of the uterus and reduced the risk of inflammation and adhesion.

The vulva, perineum and caudal part of the vagina may be examined visually for evidence of haemorrhage or laceration. The anterior vagina, cervix and uterus are normally examined for evidence of damage by the obstetrician using his hand. On occasion a vaginoscope or fibreoptic endoscope may be used to allow visual assessment of these less accessible parts.

Managerial care of the cow is generally regarded as being the responsibility of the owner or stockman but veterinary advice may encourage the provision of water and hay once the calf has been delivered. Care must be taken to ensure that if possible the cow is not allowed to eat her placenta. Harkness (1960) reported finding the partially digested placenta of a cow in her rumen 30 days after the birth of her calf. Rumenotomy had been performed to investigate clinical signs of anorexia and indigestion. The death of two cows from 'impaction and intoxication' after ingestion of their placentae was recorded by Marshall (1921).

All veterinary and managerial tasks should be completed as quickly as possible. Roberts (1971) advised the avoidance of undue excitement, noise or unusual happenings. Rest and quiet following parturition were, he considered, essential.

Detailed perinatal surveys, involving the records of 1408 and 2408 cows respectively, were carried out by Armstrong (1927) and Sloss

(1974b). In both surveys vaginal laceration and infection of the genital tract were found to be important post-parturient problems. Armstrong found uterine prolapse to be the most frequently encountered problem whilst Sloss reported a high incidence of post-parturient paralysis.

A number of specific problems may be detected during the routine post-parturient examination and some of the more important problems will be discussed below. Sloss and Dufty (1980) considered that the most important cause of damage to the cow was the pressure which built up between the walls of the birth canal and the foetus. This pressure was particularly severe in cases of foetal oversize or when the birth canal had failed to dilate sufficiently to allow unobstructed passage of the foetus. When such pressure was prolonged ischaemia and necrosis of the vaginal mucosa might occur and haematomata might develop in the peri-vaginal tissues. Compression of the pelvic nerves with resultant hindlimb paralysis might also occur.

More acute injury including laceration of the soft tissues with or without the complication of haemorrhage might arise as a result of incorrect methods of delivery or careless use of instruments. Rupture of the uterus might be caused by incautious manipulation of the foetus within the uterus and was particularly likely to occur in cases in which foetal fluids had been lost.

Haemorrhage

A moderate quantity of blood is inevitably lost at the time of parturition and as Arthur et al. (1982) observed the source of some of this blood might be the foetal placenta. Any excessive outpouring of blood from the vulva must be investigated without delay. The source of blood may be the vulva or the caudal part of the vagina in which case it may be identified and dealt with by normal surgical methods of haemostasis. When the source of blood is the anterior vagina, cervix or uterus the bleeding point may be impossible to locate although occasionally the pulsation of a ruptured artery may be palpable. Vaginal haemorrhage may be self limiting as a result of the pressure existing between the opposing walls of the vagina. Drost (1980a) warned that cervical haemorrhage might be particularly severe

and because of the brittle texture of the tissues involved, difficult to control. Involution of the uterus, aided if necessary by the administration of ecbolics, may assist in the control of haemorrhage from that organ. Arthur et al. (1982) advised removal of blood clots from the uterus on the day after such treatment in an attempt to reduce the likelihood of infection. Removal would of course have to be undertaken with great care to avoid provoking further haemorrhage.

Uterine laceration and haemorrhage may occur as a result of lay interference. Cox (1841) described a case in which profuse uterine haemorrhage occurred after an owner had attempted to correct a mal-disposed foetus. Cox reported that he successfully dealt with the case by instilling 'black oil' into the uterus and administering magnesium sulphate, opium, nitre and digitalis orally. In another case of foetal maldisposition Cartwright (1846c) reported how he encountered a massive vaginal haematoma which had resulted from lay attempts to deliver the calf. He decided to open the haematoma and failed to control the fatal haemorrhage which ensued. Fatal haemorrhage following successful correction of uterine torsion occurred in cases reported by Meyer (1926) and Hudson (1943). In the first case postmortem examination revealed rupture of a middle uterine artery and in the second blood loss had originated from a large tear in the vaginal wall.

MacGillivray (1884) described a case of arterial haemorrhage from the uterus of a cow from which the calf had been forcibly extracted. Instillation into the uterus of two pailfuls of cold water failed to control the haemorrhage which did however cease after the administration of morphia. In another case of uterine haemorrhage which occurred following correction of foetal maldisposition Hodgson (1891) reported the successful use of cold wet cloths inserted into the uterus. Motton (1914) advised the use of a roller towel steeped in antiseptic whilst Tutt (1919) reported the successful use of an injection of adrenalin and uterine lavage with perchloride of iron.

Occasionally careful search of the birth canal will allow detection of the bleeding point and Hudson (1943) described the successful application of artery forceps in such a case which developed following correction of uterine torsion. The use of blood transfusion

in such circumstances has not been described in the literature but might be required in cases of severe blood loss.

Vaginal Injury

Vaginal laceration may be described as being first, second or third degree depending upon the depth and severity of the damage (Arthur et al., 1982). In some cases the perineum is also involved and a recto-vaginal fistula may become established. Roberts (1971) observed that the vagina, being more easily dilatable, was perhaps less likely to suffer laceration than the vulva or cervix. Sloss and Duffy (1980) considered that vaginal and cervical lacerations were particularly likely to occur in cases of foetal oversize exacerbated by loss of foetal fluids and that primiparous fat animals were frequent victims. In such animals Arthur et al. (1982) observed that a common site of injury was the dorsal vaginal wall just cranial to the vulval lips. A small amount of perivaginal fat frequently prolapsed through the deficiency in the vaginal wall. They recommended that the fat should be removed and in common with Roberts (1971) and Sloss and Duffy (1980) advised immediate surgical repair of vaginal laceration. If such injuries were not repaired Arthur et al. (1982) warned that second intention healing with loss of the vaginal seal might occur. Irritation of healing wounds by uterine fluid and bacterial invasion did not predispose to rapid repair (Sloss and Duffy, 1980). Damage to the anterior vagina and cervix often were complicated by peritonitis whereas injuries situated in the dorsal wall of the vagina near its junction with the vulva, being retro-peritoneal, had a better prognosis.

Jones (1882) described a case in which a heifer with a foetus in normal disposition had been straining unsuccessfully for twelve hours. Examination revealed a large tear involving two-thirds of the vaginal circumference. He managed to deliver the foetus but made no attempt to repair the injury and the patient died from metritis and peritonitis two days later. Sloss (1974b), in his survey of post-parturient injury, found that in many cases vaginal laceration had occurred as a result of damage sustained during embryotomy.

Bruising and necrosis of the vaginal mucosa may arise during

foetal delivery and may also involve the perivaginal tissues. MacGillivray (1882) believed that ante-partum disease or abnormality might predispose the vaginal walls to injury. Motton (1914) warned that following injury the vaginal walls might become fibrosed together, later causing an obstruction to the birth canal. In the experience of Samson (1865) many animals died following treatment of dystocia with symptoms of severe inflammation of the vagina and uterus. He considered that the presence of 'large clots of extravasated blood in the areolar tissues around the vagina' was especially dangerous giving rise initially to severe inflammation and engorgement and then to 'decomposition and septic poisoning'. He advised, perhaps rather rashly, that deep incisions should be made into the lateral walls of the vagina to evacuate the clots and the parts later washed in chlorine water.

Rupture of the Uterus

Rupture of the uterus may occur either before or during birth (Hopkins and Amor, 1964; de Nooij 1981). The condition of pre-partum rupture with associated uterine inertia was discussed in Chapter Seven. Arthur et al. (1982) considered that intra-partum rupture was normally caused by manipulation of a foetal appendage, the careless use of instruments or by the obstetrician's hand. The risk of uterine rupture is constantly present when attempts are being made to correct a case of foetal maldisposition especially when the foetus or its environment have become infected and when foetal fluids have been lost.

Railton (1921) and McCorry (1932) and a number of other authors warned of the dangers of uterine rupture when the foetus was in breech presentation as a result of the foetal foot damaging the uterine floor during delivery. Further complications might be caused by the incomplete dilation of the birth canal. Cartwright (1847b) and Miles (1933) both recorded cases of uterine rupture which had occurred during attempts to deliver undiagnosed foetal monsters. In two further cases Cartwright (1864) suggested that uterine rupture which terminated fatally had occurred spontaneously and been caused by excessive uterine contraction in one of them. In both cases

however foetal maldisposition had been diagnosed and corrected and the likelihood of iatrogenic damage cannot be ruled out. Ischaemia of the uterine wall resulting from torsion of the uterus may predispose to rupture. Cunningham (1889) having successfully rolled a cow to correct uterine torsion was unable to deliver the calf until the next day. Following foetal delivery he discovered that the uterus had ruptured just anterior to the cervix but the case record does not provide sufficient information to be sure at what stage uterine rupture occurred.

Having diagnosed two cases of uterine rupture following foetal delivery Orr (1924) postulated that the problem might occur more frequently than generally believed and suggested that some cases might pass undiagnosed. Undoubtedly minor lacerations do in fact escape detection provided that infection does not gain access to the peritoneal cavity and other abdominal contents do not pass into the uterine lumen.

Mayor (1882), Morgan (1959) and Plenderleith (1963) all described cases of uterine rupture which were undiagnosed at the time of foetal delivery. In each case the cow became progressively more seriously ill at from two to fourteen days after delivery. Abdominal enlargement, suppression of rumination and a depressed body temperature were clinical signs seen in each case. Despite treatment all three cases deteriorated and died.

The treatment of uterine rupture is complicated by the inaccessibility of the organ for surgical repair in cases where the use of ecbolics to hasten involution is likely to be insufficient. Pitman and Reid (1954) and Grünert and Geyer (1964) have however described successful surgical repair with access being gained simultaneously per vaginam and via laparotomy. Drost (1980a) advised that the damaged uterus should be everted, repaired surgically and then replaced in its original intra-abdominal position. In the majority of cases however ecbolic therapy is all that is required.

Miscellaneous Soft Tissue Damage

The urinary tract may be damaged during parturition either as a result of direct trauma being sustained during foetal delivery or as a result of nerve damage or haematoma formation in adjacent tissues.

Teige (1956) considered that some degree of bladder paralysis might occur much more frequently than was suspected following assisted parturition. Pressure upon the urethra caused by haematoma formation was described by Hudson (1964) and by Sutherland (1968). In both cases the affected cow showed signs of pain and dysuria following assisted delivery. Hudson successfully removed a large haematoma from the vesico-genital pouch at laparotomy whilst Sutherland resolved his case by conservative treatment. Laceration of the urethra was reported by MacGillivray (1884) in a heifer whose oversized foetus had been delivered by forced traction. This condition also responded to conservative treatment.

Damage may also be sustained by the small intestine, portions of which may become trapped and crushed in the pelvis during foetal delivery. Ris (1933) described two cases both of which resulted in the death of the cow, the first eighteen hours and the second twenty-four hours after birth. He considered that factors which might predispose to the problem included an oversized foetus, the use of mechanical pulling devices and an overloaded alimentary tract. Moon (1939) recorded a case in which rupture of the rectal floor had occurred in a cow in which severe force had been applied during foetal delivery. Sloss and Dufty (1980) considered that intestinal damage, in common with damage to the urinary system, might be a more common sequel to assisted parturition than was realised. In a study of 955 cases of post-parturient uterine prolapse Ødegaard (1977) reported that prolapse occurring within one hour of foetal delivery was more frequently seen following cases of dystocia than normal birth.

Post-parturient Paralysis

This serious problem may be caused by damage being sustained by either the obturator or the peroneal nerve. In some cases both nerves may be affected and the condition may be either unilateral or bilateral. According to Arthur et al. (1982) gluteal nerve paralysis might also occur in cattle but Roberts (1971) believed that this form of paralysis was only seen in the mare. The incidence of obturator and peroneal paralysis has undoubtedly increased in recent

years in association with the rise in the number of cases of dystocia caused by foetal oversize. Sloss (1974b) in a study of post-parturient problems in beef cattle found that the incidence of paralysis might be as high as 9.2 per cent. The problem was especially prevalent among primiparous cattle of the Friesian and Shorthorn breeds. Armstrong (1927) had made no mention of this disability in his survey of post-parturient disease.

Fenwick (1972) and Sloss and Dufty (1980) were among authors who considered that post-parturient paralysis was particularly likely to occur when an oversized foetus had become arrested in the birth canal during delivery. Iorns (1931) felt that hasty or excessive traction might also be contributory factors. During delivery the foetus exerts considerable pressure upon the pelvic walls (Anon., 1921). Nerve damage may be sustained as a result of foetal pressure upon the obturator or peroneal nerves as they cross the medial aspects of the wing of the ilium (Sloss and Dufty, 1980). Alternatively the sixth lumbar nerve, which contributes branches to both the above nerves, may be damaged where it crosses the pelvis dorsally (Cox, 1981b).

Postmortem examination of a case of obturator paralysis by Marshall (1922) revealed a one-inch length of the obturator nerve, close to the obturator foramen, which was three times its normal diameter and surrounded by abnormal gelatinous tissue. Histological studies of affected nerves by Galabinov (1967 and 1972) revealed evidence of perineural haemorrhage and of infiltration and oedema of myelin sheaths and axons.

Obturator paralysis is characterised by an inability to adduct the affected limb (Cotton, 1932) whilst in cases of peroneal paralysis knuckling of the fetlock joint is seen. When the cow is recumbent diagnosis can be difficult and Cox (1978 and 1981b) stressed the need for very careful examination of such cases. Nerve damage was, he believed, one of four groups of causes of post-parturient recumbency the others being hypocalcaemia, toxæmia and fracture. New (1926a) observed that hypocalcaemia might be complicated by the presence of septic metritis, whilst Motton (1914) considered that 'strain of the loin muscles' might also lead to recumbency.

Fenwick (1972) pointed out that diagnosis of the cause of recumbency might be particularly difficult in cases in which the actual birth process had not been observed. Evidence of earlier foetal arrest might include oedema of the foetal tongue and a gaping, flaccid vulva in the dam. Fracture of the cow's leg, leading to recumbency, may be easily overlooked especially if no signs of pain are present (Margaron, 1931). Rainey (1955) considered that rupture of the teres ligament should always be considered in the recumbent cow.

Secondary complications including pressure sores may develop quite rapidly in the recumbent cow. Fenwick (1972) observed that dislocation or even fracture of the hip joint might occur in up to twenty-five per cent of cases. Studies on anaesthetised cows by Cox et al. (1982) demonstrated that severe muscle damage often of an irreversible nature might develop after only six hours recumbency.

There is evidence that damaged nerves may regenerate after some weeks or months and provided that the cow can be nursed satisfactorily, time may be allowed for possible recovery. The weight of the cow, the difficulty and expense of nursing care and the high incidence of secondary complications are factors which contribute to a very guarded prognosis in affected animals. The case must be subjected to regular re-assessment and unless progress is made within a few days the cow may have to be slaughtered. Sloss and Dufty (1980) considered that favourable prognostic signs included a bright appearance, a good appetite, rapid involution of the uterus and rapid healing of soft tissue damage. Heavy animals had a poorer prognosis than lighter animals. Fleming (1877) believed that if the animal could remain standing, even if only for a very short period of time, she would probably recover eventually, although some difficulty in walking might persist for weeks or months.

In the early stages every effort should be made to encourage the animal to stand and the use of the Bagshaw hoist (Harrison, 1958) or inflatable cow-lifter may be of some help. The author has found that the Bagshaw hoist can normally only be used on a few occasions since repeated use is liable to cause severe soft tissue damage over the coxal tuberosities - the point at which the device is attached. Sloss and Dufty (1980) advised that animals should only be repeatedly

hoisted if there was evidence that they could bear weight upon their limbs.

In some cases, where there is no evidence of severe physical damage, stimulation may be applied to encourage the cow to rise. Thomas (1957) and Toovey (1957) both recommended electrical stimulation whilst Fraser (1952) found that the administration of anti-histamine had a beneficial effect in some cases. The introduction of a strange dog may occasionally encourage a recumbent cow to attempt to rise and a strong protagonist of this method was Barlow (1929). He wrote 'get a small dog, educate him a little and he will prove a better remedy than nux vomica'. Rutter (1929) considered that such canine assistance might be of value in encouraging a freshly calved cow to rise but was unlikely to help in cases of true recumbency. Mayall (1929) recommended the application of a 'hot smoothing iron' to the cow's back.

Good nursing care is essential and can be difficult to provide under farm conditions. A firm non-slip surface should be provided and the avoidance of concrete flooring was strongly advised by Toovey (1957). Hobbling the hind limbs of affected animals may help to ensure that attempts to rise have a better chance of success and to prevent further damage from being sustained. It has been suggested (Fenwick, 1972) that application of a plaster cast to the fetlock joint in cases of peroneal paralysis may help to provide joint stability. Iorns (1931) advised application of embrocation to the backs of affected animals whilst Cox (1981) recommended the use of corticosteroids in an attempt to reduce perineural inflammation.

The difficulties associated with the diagnosis and treatment of post-parturient paralysis and the grave prognosis which must be given, led Fenwick (1972) to urge that every effort should be made, by good obstetrical care, to avoid conditions likely to predispose to its onset.

DISCUSSION

This thesis is, it is believed, a unique review and discussion of the large number of references in the literature to the subject of bovine dystocia. It is hoped that it will provide a useful source of information to other workers and also act as a tribute to the many authors whose work has been cited. Each of the authors has made some contribution, small or large, to our knowledge of bovine obstetrics and it is perhaps unfair to single out from among their number any for special mention. Tribute must be paid however to William Percivall and William Youatt who as founding editors of the *Veterinarian* in 1828 stimulated the young profession in Britain to record its findings and experiences in practice and thus contribute to and disseminate an increasing fund of knowledge. George Fleming was perhaps 'a unique provider of textbooks' (Anon, 1930a) for his pen was indeed prolific but, had it not been for his great industry, the British veterinary profession would not have received its first Textbook of Veterinary Obstetrics in 1877. Much of the material in Fleming's book was undoubtedly freely taken from continental tomes but it enabled the British reader to have access to reasonably up-to-date information in his own language.

Sir Frederick Smith who chronicled the history of British veterinary literature sagely remarked that historical research took much time. Many of the early journals studied by the present author had no index and thus required cover to cover perusal to obtain information on the subject matter of this thesis. A strong will was frequently required to resist the temptation to deviate from the subject of study and follow up numerous other matters of interest that filled the pages.

In each chapter of the thesis the author has described and discussed the development and advancement of knowledge which has taken place in that particular area. For the most part progress has been steady and as in other scientific fields the need for critical research has been recognised. From time to time however in the history of bovine obstetrics certain major advances in knowledge or technique have occurred which may be regarded as milestones in the path of progress. Van Staa's invention of the flexible embryotomy wire and the intro-

duction of epidural anaesthesia by Benesch were examples of important developments whilst the passage of the Protection of Animals (Anaesthetics) Act in 1954 was instrumental in reducing some of the hazards of caesarean section and thus enabling the operation to become a routine procedure in bovine obstetrics. In more recent years rapid advances in our knowledge and understanding of endocrinology have assisted in the development of techniques for both the strategic induction and the suppression of parturition.

Despite the steady advance of knowledge a number of problems relating to various aspects of bovine dystocia remain to be elucidated and if possible solved. Establishment of the incidence of a problem is a necessary part of its study and investigation. An accurate knowledge of the incidence of bovine dystocia should not only quantify the frequency with which it occurs, but should also give an indication of the severity of economic loss and the distress which may be associated with it.

A number of surveys of the incidence of bovine dystocia have been discussed in this thesis but none can be regarded as being ideal. The smaller surveys, carefully recorded and evaluated by one or two clinicians, although valuable, seldom cover enough cases to allow statistical evaluation of the results. Surveys involving large case numbers are perhaps more attractive to the statistician but may suffer the major disadvantage that their data is of questionable value. In most cases the data has been contributed, albeit in good faith, by a large number of untrained observers. Such surveys are subject to serious error for a number of reasons. The point at which a normal calving becomes a case of dystocia is difficult to define and may be subject to different interpretation by various observers. Undoubtedly many cases of assisted parturition might have given birth unaided had they been given more time. Another major source of error may be a reluctance upon the part of the observer, especially if he is the herd owner, to publicise the problems and losses which he is experiencing. A guarantee of anonymity might help to alleviate this particular problem.

In the present author's view the most accurate survey of incidence of bovine dystocia would be one conducted by a number of clinicians

working in areas of high cattle population. Parameters of normal and abnormal parturition would be agreed and cases to which veterinary help had been summoned, but which in the clinician's view were not true cases of dystocia, would be rejected from the survey. Very careful planning and agreement would have to precede such a survey. Details of breed and age of the dam together with those of the sire and measurements of the calf would be taken and preferably coded to allow later evaluation by computer. Other details of such parameters as herd size and management might also be recorded but ideally the survey should remain reasonably simple since the busy clinician may be reluctant to fill in long questionnaires. This in itself may lead to a tendency not to complete the questionnaire at the time and predispose to greater inaccuracy.

Since an individual parturient cow cannot be both assisted and un-assisted at the same time the problem of establishing guidelines between normal and abnormal birth is extremely difficult. A simple definition of dystocia would be a case of parturition which required either the stockman's assistance or that of the veterinarian. Immediate difficulties would arise with such a definition since the tendency to interfere or to seek veterinary help varies greatly from farm to farm. The duration of labour might be used to identify a case of dystocia but recognition of the point of commencement of the first stage of labour without the use of an intra-uterine manometer is impossible. It was suggested by O'Mary and Hillers (1976) that the time required for the foetal head to appear after the appearance of the foetal feet was an accurate indication of the likely duration of second stage labour. In the present author's view the concept of measured foetal progress through the birth canal might be useful as an indication of dystocia. It would not however be suitable for all cases. Whilst it could be used to recognise dystocia in cases of foeto-pelvic disproportion it could not be used in cases of malposture such as lateral deviation of the head since the latter extremity would not appear at all even if the foetal forefeet were visible at the vulva. Lack of any foetal progress over a finite period of time or delayed foetal progress might both be used as an indication of dystocia. Such definitions would of course have to be modified when dealing with cattle of differing age or breed.

Despite the difficulties of conducting meaningful surveys of the incidence of bovine dystocia, some of which have been mentioned here, it is essential that such surveys are made. It is only through such surveys that the extent of the problem can be evaluated and an indication obtained as to whether the problem is increasing or decreasing. Sloss and Dufty (1980) using data obtained from worldwide sources estimated that the incidence of bovine dystocia might be as high as 27% of all calvings although lower figures had been recorded in some surveys. The present author however believes that a higher incidence than this is not infrequently encountered. Mention was made in the thesis of the high incidence of dystocia among heifers of the Belgian Blue-White breed in which up to 80% of parturient animals might require assistance. Such figures must be regarded as both exceptional and unacceptable but in a number of well-managed herds of Friesian cattle in Britain the author has encountered an incidence of dystocia of up to 45%.

Numerous factors are known to influence the incidence of bovine dystocia and the relationship between individual factors is complicated and whilst a high degree of correlation between some factors has been demonstrated, in other cases the degree of correlation has been too low to allow accurate prediction of the incidence of dystocia (Fagg et al., 1975).

It is generally agreed that the two most important factors affecting the incidence of dystocia in cattle are the size of the foetus and the dimensions of the maternal pelvis. Calf size is influenced by many factors including the breed of its sire, the age of its dam and the sex and gestation length of the foetus. Gestation length is in turn influenced by other factors including the breed and sex of the calf and paternal influence which has been termed 'sire effect'. The importance of the individual factors has been very difficult to evaluate. Although the heritability of many factors has been shown to be low, the true influence of each individual factor would be helpful to a greater or lesser degree in any attempt to reduce the incidence of dystocia.

The technique of embryo transfer is now well established and it is also possible to split the harvested embryo into two identical twins which can then be re-implanted into recipient dams of the same or differing breed. This technique offers an exciting possibility of elucidating the rôle of some of the many factors affecting the

incidence of dystocia and of course many other livestock problems in which evaluation of the relative importance of genetic and environmental influences is required. An embryo harvested from a purebred Charolais mating could be divided and transferred to the uterus of a Jersey cow and also to the uterus of the same or another Charolais dam. At parturition the size, gestation length and other parameters of the two calves would be measured and compared. Since the calves were genetically similar the influence of factors such as the breed of the host mother on gestation length could be determined.

Another problem confronting the student of bovine dystocia is the difficulty encountered with some cases of deciding what is the cause of dystocia. In many cases the cause is obvious: for example in the heifer which has been the victim of misalliance and in which gross foetal oversize is responsible for dystocia. In other cases it appears that a number of factors are involved. Examination of the cow may reveal that the foetus is slightly oversized, that the cervix is not fully dilated and that uterine contractions are somewhat weaker than usual. All the factors mentioned have probably exerted some influence upon the abnormal parturition. To classify the cause in a single category for the purposes of a survey would be difficult if not impossible. It could be argued that since uterine contraction is responsible for much of the first stage of labour that such a case should be described as primary uterine inertia. In such a case however it would be difficult to be sure that loss of uterine contractions might at least in part be a secondary uterine inertia resulting from the degree of obstruction caused by a failure of the cervix to dilate fully and from the mild degree of foetal oversize which was also present. Arguably in any survey of cause of bovine dystocia a category entitled 'multifactorial' should be included for cases such as that described in which no single factor can be incriminated.

Numerous examples of soft tissue obstruction causing dystocia have been encountered in the literature and have involved individually almost every part of the birth canal. Anatomical abnormality was found to be not uncommon but the two most important conditions were failure of the cervix to dilate and obstruction of the anterior vagina resulting from uterine torsion.

Failure of the cervix to dilate can be a most difficult problem for the clinician. Despite the attempts by Rosenberger (1979) to differentiate between the cervix which is likely to dilate given a little more time and that which through previous scar tissue formation is unlikely to do so it can be extremely difficult to decide upon the best course of action when confronted by cervical obstruction to birth. In practice other factors such as the time available and the duration of the case may precipitate a course of action. Caesarean section may provide a satisfactory solution to the problem in the field but further study of the periparturient changes in the normal and abnormal bovine cervix would undoubtedly enable cervical function and malfunction to be better understood. Endocrinological, neurological, biochemical and structural factors are all involved and some of the preparatory changes in the cervix probably commence weeks prior to parturition. Serial palpation, visual inspection and biopsy in animals which progressed to normal or abnormal parturition would provide interesting information on cervical function. Hormone assay of blood from the ovarian circulation would provide further information about the effects of the ovarian hormones on cervical function.

Many different treatment régimes for failure of the cervix to dilate have been described in the literature. Rather bizarre methods have been proposed such as inflation of the bovine urinary bladder by cycle pump after insertion into the cervical canal (Anon., 1910). The hazardous technique of vaginal hysterotomy was very popular at one time but has been largely superseded by caesarean section. A number of authors have described the successful use of drugs such as oestradiol benzoate and vitamin D but in the view of the present author there is little evidence that the cervix really dilated as a result, rather than in spite of, such therapy. Recently some success has been achieved following application of prostaglandin E to the bovine cervix to stimulate relaxation and dilation of that organ - a technique which has been used successfully in human obstetrics for a number of years.

Despite the fact that twinning occurs in approximately two per cent of all bovine pregnancies, the cow is essentially a monotocus animal ill-equipped to deal satisfactorily in many cases with the delivery of more than one foetus. Attempts to increase the incidence

of twinning in cattle as an aid to increased beef production proposed by Hammond (1959) were followed by the predicted difficulties and the concept was abandoned. Implantation of a second embryo into the pregnant bovine uterus has been successfully performed (Boland and Gordon, 1978) and the technique of embryo-splitting already mentioned above has provided another method of encouraging twin pregnancy in the cow. The present author can see little advantage in such procedures since a high incidence of dystocia and post-parturient disorders is still likely to occur. When twinning has been induced however and twin birth is anticipated careful supervision of parturition and active management of the post-parturient uterus could lead to the avoidance of the normal attendant problems.

Foetal maldisposition is an important cause of bovine dystocia and defects of presentation, position and posture either alone or in combination may be seen. The particular problems for the foetus in posterior presentation have been discussed and the author has suggested that this presentation should be regarded as being abnormal. The risk of premature rupture or of compression of the umbilical cord are higher than for the foetus in anterior presentation which normally has earlier access to atmospheric air. It has been suggested that passage of the foetus in posterior presentation through the birth canal might be delayed by increased friction from the hair of the foetal coat (Williams, 1917; Roberts, 1971). In the present author's view this is only likely to be of significance in cases in which loss of foetal fluids has occurred with consequent loss of natural lubrication. Although considerable foetal movement in utero occurs during pregnancy Arthur et al. (1982) considered that foetal presentation was unlikely to change after the sixth month of pregnancy. This useful fact should allow detection of foetal posterior presentation before the time of parturition as part of a programme of ante-natal care including rectal examination. Prior knowledge of the posteriorly presented foetus would enable special vigilance to be exercised at the time of birth, greatly reducing the hazards to foetal life mentioned above.

The basic causes of foetal malposture including displacement of the head and limbs are not well understood. Although it has been observed that the circulating levels of steroid hormones may be altered

in the cow in which foetal malposture has occurred, other factors are without doubt also involved. It appears that the somewhat unusual posture adopted by the foetus at birth is practised by the foetus on a number of occasions prior to birth (Dufty, 1973). The innate ability of the foetus to adopt a suitable posture for birth is truly remarkable since the posture is rarely adopted in post-natal life. Once a defective posture is adopted however it is almost inevitably compounded when the foetus comes in contact with the rigid bony pelvis.

Further study into the causes of foetal maldisposition would be most useful to the obstetrician especially if, as a result of such study, it became possible to identify during late pregnancy the foetus which was likely to suffer this abnormality at birth. Two lines of research would be required to evaluate the problem, involving the pre-partum and the post-partum foetus respectively. In the pre-partum phase the foetus would be studied experimentally at various stages of pregnancy. Its ability to respond to changes of posture and its ability to adopt the normal birth posture would be evaluated under conditions of anoxia and abnormal levels of maternal hormones. Foetal response to varying levels of steroid and pituitary hormones involved in the birth process might provide interesting information on the importance, if any, of these substances in normal and abnormal foetal posture. The exact rôle played by uterine tone in relation to foetal posture is also unclear and the influence of oxytocin and prostaglandin $F2\alpha$ on the foetus requires further evaluation. If invasive surgery were possible selective areas of the foetal brain could be stimulated or suppressed and their influence upon the ability to correct malposture or to adopt the posture of normal birth thus evaluated.

Study of the post-partum foetus, especially if it was known to have suffered malposture at the time of birth, might be particularly rewarding. Neurological, behavioural and biochemical studies of such animals would be undertaken and the results compared with those from animals in which birth had been uneventful. Neurological tests would include assessment of postural reflexes including proprioception whilst behavioural studies would include the ability of the foetus to suck and establish its side of the foeto-maternal bond. Biochemical studies would include evaluation of blood glucose, lactate and urea levels and

also blood gas analysis in an attempt to assess the rôle of stress including anoxia upon foetal posture.

The problem of foetal oversize is a serious one and in any discussion of calving difficulties must receive special attention. In some cases the excessive foetal size is pathological, resulting from foetal death and emphysema. In the majority of cases however the problem arises from the use of breeding stock from which the risk of producing an oversized foetus is clearly appreciated. In Belgium the use of double-muscled bulls of the Blue-White breed with the intention of producing oversized calves which cannot be delivered naturally is, in the view of many, indefensible. It should be pointed out however that so high are the standards of parturient care in that country that despite the fact that caesarean section may be required in up to 80 per cent of all calvings, very high levels of foetal and maternal survival are achieved. The reasons why such good results are obtained will be discussed below.

Successful delivery of the oversized foetus without damage to either mother or offspring is often a taxing problem for the obstetrician and some degree of damage is probably inevitable. The risk of foetal death occurring during delivery of the oversized foetus, possibly as a result of obstetrical misjudgement, has led to a search for a reliable method of assessing foetal size in relation to the dimensions of the maternal pelvis before attempts at delivery per vaginam are made. Any guidelines which could assist the clinician in this decision would be most valuable. The present author has found that with experience it is often possible by careful palpation of the foetus and the maternal pelvis to decide when vaginal delivery is likely to be successful. The veterinary student and young graduate are naturally lacking in experience and find this particular problem a matter of great concern since an incorrect decision may be followed by disastrous consequences.

Hindson (1978) proposed a formula relating the inter-ischial diameter of the maternal pelvis to the digital diameter of the foetus and suggested figures for the ratio between these two measurements above and below which delivery by traction should or should not be attempted. A later report (Hindson et al., 1984) described an electronic device which enabled the digital diameter of the foetus to be measured per

rectum prior to birth and which would provide an early warning of possible problems ahead. Hindson's formula was greeted with considerable enthusiasm by the profession. Unfortunately a number of reports - with which the present author's experiences concur - suggested that the formula might not be quite as reliable as the original author had believed.

Mention was made within the text of this thesis of the advice given by Armstrong (1978) and by Schuijt and Ball (1980) concerning the detection, prior to the application of traction, of foeto-pelvic disproportion. Gentle and controlled traction was to be applied to the extremities of the foetus and movement along the birth canal as a result of this traction was to be used to predict the likelihood of successful delivery. The present author has not had the opportunity to evaluate these methods in the field but they are undoubtedly worthy of further study. Such traction should however also be controlled by a time limit beyond which further traction ought not to be applied. If traction applied for five to ten minutes fails to move a calf in normal presentation it should be abandoned for an alternative method of delivery. The degree of traction applied should also be quantified. Traditionally it has been expressed as the pulling force of a certain number of men. The strength and competence of assistants varies greatly but in the author's opinion the help of two assistants applying traction is normally sufficient and the number should never be more than four. It has been suggested that the veterinarian himself should never apply traction but rather should direct and supervise the operation. This suggestion has considerable merit but the personal application of traction - often necessary through lack of assistance anyway - may enable the veterinarian to more readily appreciate the degree of traction being applied. The use of the H.K. calving aid to apply traction will be discussed in greater detail below but, when it is used as a substitute for human aid in the application of tentative traction, it should not be applied with a force greater than that applied through its handle by one man.

Any discussion of the degree of traction which may be applied to a foetus must include consideration of the state of wellbeing of that foetus and the need for simple but effective means of monitoring at

least foetal pulse rate has been emphasised in this thesis and is further discussed below. If it can be established that the foetus is suffering some degree of anoxia and is unlikely to survive vaginal delivery, especially if the latter is prolonged, then a decision to proceed to operative delivery may be made without traction being applied. Such a decision would of course presuppose a readiness on the part of the veterinarian to proceed immediately to caesarean section. Should it be established in a case of foeto-pelvic disproportion that the foetus is dead, then a slightly greater degree of traction might be applied but only within the bounds of humanity to the cow.

Many of the problems of foeto-pelvic disproportion can be avoided by a sensible breeding policy. Unfortunately the practising veterinarian is not infrequently presented with a situation in which such a policy has either not been followed or the farmer considers that he must run the risk of this type of dystocia if he is to produce calves which will be attractive to future purchasers. When confronted with a breeding herd in which a number of potentially dangerous pregnancies have been established, attempts may nonetheless be made to avoid difficulties at parturition. Drastic reduction in maternal food intake in an attempt to reduce foetal size at term has been proposed and indeed used in the field but may in fact be counter-productive. Not only may the foetus continue to grow unchecked, but the condition of the mother may deteriorate to such an extent that she is no longer capable of parturition. Furthermore Joubert and Van Marle (1959) considered that the foetus normally had priority over the accessory tissues in poorly fed cows and in such animals reduction of placental size and in the volume of accessory fluids might complicate parturition.

Prolonged gestation, contributing to foetal oversize, has been seen in the progeny of some animals, especially those of the Continental breeds. In such cases induction of birth has proved to be a useful method of terminating pregnancy before excessive foetal growth has occurred. Male calves are especially likely to reach oversized proportions and Bongo and Basrur (1975) proposed sex differentiation by means of karyotyping foetal tissues following amniocentesis to identify the presence of a male, potentially large, foetus. Such information

would undoubtedly be helpful but as Mitchell and Eaglesome (1975) pointed out the suggested technique was not only likely to induce abortion in a proportion of cases but problems might arise in obtaining the correct samples with certainty. Basrur (1975) however reiterated his belief in the accuracy and safety of the method. Although this technique is interesting it is, in the present author's view, unlikely to become standard procedure for the potentially oversized foetus.

Strategic induction of birth has proved a useful technique in preventing excessive foetal growth occurring in association with prolonged gestation. Many different régimes have been described involving the use of corticosteroids and prostaglandin F_{2α} and its analogues either alone or in combination. A number of authors have wisely recommended careful client counselling to ensure that the farmer is aware of the potential problems of induced birth in cattle and properly prepared to provide extra care and attention to both the dam and calf.

One difficulty which may occur in practice is that unless breeding has been carefully supervised the prospective calving date of a cow carrying a potentially oversized calf is not accurately known. Late induction of such an animal may fail to avoid the problems of foeto-pelvic disproportion whilst early induction may result in the delivery of a premature, non-viable foetus. Measurement of foetal crown-rump length, a reasonably accurate parameter of foetal age, cannot be undertaken in late pregnancy under field conditions. The state of preparation for birth shown by the dam may be of some value but, as discussed in the section of the thesis devoted to normal birth, the timing of some pre-partum changes varies greatly between individual animals. The present author has found that an accurate assessment of foetal maturity can be obtained by rectal examination. The size of the foetal limbs, the presence or absence of foetal hair and the degree of keratinisation of the hooves have all been found to be useful parameters in the assessment of foetal development.

In the case of the farmer who feels obliged to persist with the production of potentially oversized calves for economic reasons helpful advice may also be given. In the short term induction of birth may avoid some of the worst consequences of foeto-pelvic disproportion.

In the longer term careful selection of breeding stock may be found beneficial. Appraisal and recording of calving ability will enable breeding stock to be selected from strains of cattle in which a low level of dystocia has been reported. The size of the maternal pelvis of heifers retained for breeding may be measured either directly or indirectly. Pelvic area may be calculated from measurements of the lateral and dorso-ventral diameters of the pelvis taken per rectum with the aid of a human pelvimeter. Animals with a pelvic area of less than 200 cm² should not be presented for breeding. Such measurements may however be difficult to obtain with accuracy and the formula of Ben David (1980) relating pelvic circumference to the distance between the coxal tuberosities can be used to give an indirect assessment of pelvic size. Animals should only be retained for breeding if at the time of service the distance between the coxal tuberosities is greater than 40 cm.

Early attendance upon a case of bovine dystocia is a prerequisite of good obstetrical practice and clients should be encouraged to report suspected problems as soon as they are observed. There can be no substitute, in the present author's view, for a personal visit to examine and assess a case even if it is decided that no immediate action is necessary.

The concept propounded in some of the American literature of a special parturition facility on the farm is an attractive one and might be an economical possibility on the larger unit. Undoubtedly such facilities with good methods of restraint and an atmosphere of cleanliness and efficiency have much to recommend them. In recent years a considerable expansion of herd size has occurred and as Blackmer (1980) observed farmers do not always have the knowledge or the facilities to deal with the increased number of cows. Provided management is good, increasing herd size need not necessarily have a detrimental effect upon calf mortality at birth. Speicher and Hepp (1973) in a survey of 379 dairy herds found no relationship between herd size and stillbirth rates.

Regrettably the veterinarian is seldom involved in the planning of farm premises being only called in when problems, often relating to design, have been encountered. Whenever possible he should however

press for the best possible calving facilities for the cow which also enable unobtrusive observation to be made and effective assistance given if required. Few farms have good facilities and the veterinarian must do his best often in difficult circumstances. Fortunately the availability of xylazine as a sedative has enabled even the most fractious of parturient animals to be handled in comparative safety. In whatever circumstances the veterinarian finds himself, high standards of hygiene and cleanliness in dress and work are essential both to maintain good professional conduct and to set an example for lay helpers to emulate.

The equipment taken to a case of bovine dystocia is a matter of personal choice and is naturally dependent upon what is available in the practice. Although most cases can be dealt with using two or three nylon calving ropes, more sophisticated apparatus can be extremely useful at times. In the present author's view the H-K calf puller and an embryotome form an essential part of the calving kit along with adequate supplies of such ancillaries as lubricant and local anaesthetic. The engineering ability and ingenuity of 19th century instrument makers was outstanding and some examples of their fine work have been illustrated in this thesis. Other examples are preserved in the museums of veterinary schools and some are still in active use. Although most people would agree that many of these instruments have no part to play in modern obstetrical practice, it is difficult to suppress some feelings of nostalgia and admiration when viewing their fine craftsmanship.

In recent years the incidence of acute peri-parturient mastitis has increased and the life-threatening nature of this disease has emphasised the necessity of careful clinical examination of the cow attended for reasons of dystocia. Fortunately lay interference is less rife than in earlier times but nonetheless the veterinarian must be constantly vigilant for signs of previous interference especially when damage has resulted.

Foetal assessment in the dystocia case is difficult. Although means are available for the measurement of foetal pulse rate and of blood gas parameters they are not in routine use. Further development and simplification of such measuring device is urgently required if accurate foetal monitoring - so essential to good obstetrical practice -

is to become standard practice especially if there is evidence that foetal life may be at risk. Richardson and Higgins (1981) described the use of an external transducer probe to demonstrate signs of foetal life by Doppler ultrasound from day 130 of gestation until term. This simple technique is very attractive but the author has not found it reliable under practice conditions. Maternal movement at the time of parturition can increase extraneous noise from the loudspeaker of the machine to an unacceptable level, masking sounds of the foetal heart. The author has also found the use of Doppler ultrasound of little value to monitor foetal pulse in late pregnancy in other species. In the ewe it has been found that foetal pulse may be readily monitored until some two days prior to parturition after which it becomes impossible to detect using an external probe. The movement of the foetus up into the pelvic inlet may be partially responsible for this problem and once parturition commences, loss of uterine fluid and the presence of air within the uterus does not provide a satisfactory medium for transmission of ultrasound waves.

The use of the H-K calf puller or similar devices for the mechanical application of traction is the subject of considerable controversy. Andrew (1977) reported an apparent increase in the number of cows seen both in practice and at the abattoir showing signs of pelvic damage which he attributed to the use of calving aids by unqualified persons. The use of such apparatus is forbidden or restricted by law in certain countries and in Britain the Code of Conduct for the welfare of livestock (Anon., 1983) advised that their use be restricted to those persons who had received proper instruction.

The present author is convinced that in careful hands mechanical aids to traction can be of great value especially when assistance is limited. The restriction in their use to the veterinary profession, although highly desirable, would be difficult to enforce.

Caesarean section has rightly become accepted as a normal procedure in veterinary obstetrics. Almost every survey of the results of caesarean section has stressed the necessity of the operation, when indicated, being carried out as soon as possible during the case and upon a cow in good condition. As might be expected the chances of foetal survival are greatly increased by an early decision to proceed to surgery and the risks of post-parturient complications are reduced.

Results in the field have not always been as satisfactory as might have been expected. The cow in some cases may fail to do well either in terms of milk production or subsequent fertility whilst in other cases the calf may fail to thrive. Discouraged by poor overall results, some veterinarians and farmers are reluctant to recommend or permit the operation respectively. In cases of dystocia in which vaginal delivery cannot be achieved the cow is sent immediately for emergency slaughter and caesarean section is not attempted.

In Belgium caesarean section is widely practised with apparently excellent results. It is not uncommon in that country for a cow to have five or more caesarean sections during her lifetime and infertility and other complications are rarely seen. It is clear that there must be a reason or reasons why so much better results are obtained in Belgium than are experienced in Britain. Undoubtedly one of the most important reasons for this success is early recognition of the need for caesarean section and a number of factors contribute to this. Most Belgian practitioners are single-handed, their practices are geographically small and clients' farms are within easy and rapid travelling distance. Parturient cows are subjected to very careful scrutiny and since most of the farms are staffed by the owner's family, day and night observation can be provided at low cost. Caesarean section is readily accepted by the farming community and in some cases when a double-muscled calf is expected the cow may be clipped up for surgery in advance of the time of parturition. During the calving season Belgian veterinarians carry a very simple pack of instruments with them and are ready to perform the operation at short notice. In many cases the veterinarian is called to examine the cow as soon as she is observed to enter second stage labour.

On arrival at the farm the veterinarian makes a rapid appraisal of his patient and observations by Sutherland (personal communication) revealed that on occasion operative surgery began within ten minutes. The lower limbs of the Belgian Blue-White calf are often deceptively small and signs of foeto-pelvic disproportion are recognised by palpation of the upper portions of the foetal limbs just anterior to the maternal pelvis. Although great care is taken with preparation of the left flank for surgery, the operative procedure is carried out

under antiseptic rather than aseptic conditions. Instruments are not routinely boiled but are immersed in antiseptic solution before use. Local infiltration anaesthesia is employed, each layer of the flank wall being injected just prior to its incision. Since little time has elapsed before surgery the pregnant uterus is readily exteriorised for incision through the laparotomy wound. The umbilical cord is carefully protected during foetal delivery to ensure that it is not crushed prematurely or pulled from its umbilical attachment. Following foetal removal great care is exercised over the repair of the uterine and flank wounds. Each layer is sutured separately and following repair each suture line is liberally dressed with an application of injectable antibiotic and corticosteroid. Such is the skill of the veterinarian that in many cases he will have completed the operation and left the premises within 45 minutes of arrival.

The secret of the Belgian success is in the author's view related to the rapid decision to perform caesarean section supported by the farmer's willingness to permit surgery. A simple anaesthetic technique combined with dextrous surgery and in particular meticulous wound repair are also important factors. Belgian veterinarians are of course well practised in the technique of caesarean section and it has been argued within this thesis that the level of operative treatment of dystocia cases caused by foeto-pelvic disproportion is unnecessarily and indeed unacceptably high. Nonetheless British colleagues cannot fail to be impressed by the high success rate achieved.

This study of bovine dystocia has brought together a large amount of factual information. It has revealed the extent of published knowledge on the incidence, causes, economic consequences and methods of treatment and prevention of the problem. The extent of knowledge, were it to be fully applied and utilised, should ensure that bovine dystocia was an extremely rare occurrence and indeed might be avoided altogether. Even if the occasional difficulty did arise then modern methods of diagnosis and treatment, developed and improved over many years, should ensure rapid resolution of the problem without loss of foetal or maternal life. In fact the incidence of dystocia remains unacceptably high and the current rate of stillbirth, also far too high, is indicative that for various reasons our knowledge is not being properly applied.

It is probably inevitable that difficulties such as foetal mal-disposition will occasionally arise during the complicated process of birth. Dystocia due to foeto-pelvic disproportion is however in many cases fundamentally caused by careless breeding policies or a deliberate attempt to obtain the largest possible calf despite the risks that this entails.

In many cases bovine dystocia may be minimised or avoided by sensible breeding policy and good supervision of parturition. Selection of well-developed and healthy breeding stock from 'easy calving' strains should predispose to a low incidence of dystocia. Once pregnancy has been established a programme of planned antenatal care should follow but regrettably this is often non-existent or at best cursory. A high standard of management during pregnancy is most important and routine clinical examination of the pregnant animal as the time of parturition approaches would have many advantages. Signs of impending difficulties such as foeto-pelvic disproportion or posterior presentation could be detected before birth and allow special care to be given to those animals in which potential problems were anticipated.

It has been shown that diligent supervision of parturition may result in a lower level of stillbirth. Over-enthusiastic supervision however may give rise to an apparent increase in the incidence of dystocia and must be avoided. Early recognition of abnormalities and difficulties by the stockman will enable prompt veterinary attention to be sought and in most cases ensure that the problem is brought to a speedy and successful conclusion. Education of both farmer and stockman is obviously important as is the provision of animal accommodation which enables supervision to be efficient and unobtrusive. It is also very important in the present author's view that veterinary students should be taught how best to advise the farmer on the proper supervision of parturition and the recognition of dystocia. They should also be well versed in and prepared for the treatment of dystocia cases encountered in practice. It is impossible to provide sufficient case material or tuition during the undergraduate course to enable the student to become a proficient and experienced obstetrician by the time of graduation. In many of the continental veterinary schools farmers from a wide catchment area are able to bring their animals directly in for treatment with the result that many cases of bovine dystocia are available for student teaching. Mention was made within this thesis

of the arrangement in Utrecht whereby the already large case load of obstetrical cases is supplemented by the purchase of parturient cattle upon which students may perform either embryotomy or caesarean section. Students undoubtedly benefit from the experience gained, but such animal usage would be unacceptable in Britain. Students in this country are of course exposed to cases of bovine dystocia whilst seeing practice but the amount of case material each student sees and his personal involvement in its treatment varies greatly. There can be no substitute for experience which can be quickly gained by the new graduate in his first few years in practice but in the present author's view the value of this experience can be greatly enhanced by good undergraduate tuition.

University courses in reproduction have two main components - obstetrics and infertility. Developments in the latter component during the last two decades have been spectacular with the result that less time is available for the study of obstetrics. It may be only possible to deal with the broad principles of obstetrical technique in lecture time although this can be supplemented in practical classes with the aid of a calving simulator. As much time as possible should be spent in description and discussion of specific causes of bovine dystocia. The teacher must however be constantly aware of the dangers of dogmatic instruction which is likely to close the student's mind to original thought since this would clearly be a retrograde step. Many of the important advances in the treatment of bovine dystocia have resulted from the ideals of individuals who have had the courage and forethought to put them into practice.

Antenatal care and especially the provision of labour for out-of-hours supervision of parturition is costly and indeed the cost may be so high that the farmer may be tempted to 'take a chance' that all will be well - often with disastrous consequences. The use of clenbuterol to suppress parturition during the hours of darkness is a promising development and the observation by Lowman et al. (1981) that adjustment of feeding time might influence the time of parturition is extremely interesting and worthy of further study. Both these developments may not however be readily acceptable to the farmer but evidence of good results from these régimes might encourage his acceptance of

them. The use of closed circuit television to enable remote supervision of the parturient cow has been used in Europe but such observations can never completely replace direct observation.

As has already been discussed the development of reasonably safe techniques for the induction of parturition in cattle has provided the obstetrician with another valuable tool for the prevention of dystocia. When an error of breeding such as misalliance, is recognised termination of pregnancy can be carried out. The technique is also invaluable when a group of heifers or cows have started to calve and severe problems are experienced with dystocia due to foeto-pelvic disproportion.

Perhaps the most serious development in cattle breeding in recent years has been the deliberate attempt by some farmers to produce calves which almost certainly cannot be delivered by natural efforts. The unacceptably high level of caesarean sections used to deliver calves of the Belgian Blue-White breed has been the subject of considerable discussion above. A number of animals of this breed have recently been imported into Britain and the necessity for operative delivery of the calves in many cases has already been reported (Sutherland, personal communication). Public opinion is in the author's view unlikely to support the establishment in this country of herds of animals which, despite the high value of their calves, are unable to give birth naturally.

Advice on the prevention of dystocia is available for all who wish to take it. The Code of Recommendations for the welfare of livestock: Cattle (Anon., 1983) was distributed to all stock farmers in the United Kingdom. Paragraph 64 of the document advised 'When breeding, especially from maiden heifers, sires should be carefully selected, taking into account breed, size, age and previous record, so as to reduce the likelihood of subsequent calving difficulties. Cows and heifers should be managed so as to be in suitable bodily condition at the time of calving. Stockmen should be experienced and competent in the techniques of calving and should pay particular attention to hygiene especially at assisted calvings. Mechanical aids should only be used by a competent person who has received proper instruction in their use. Veterinary advice should be sought at an early stage if difficulties are suspected'.

The knowledge is available to drastically reduce the incidence of bovine dystocia and thus to contribute to the health and comfort of the species. It is difficult to justify not using this knowledge to the full. The economic advantages of running the risk of dystocia are easy to understand but cannot be justified on welfare grounds. There is possibly a case for legal enforcement of the code of welfare described above, although it is recognised that legislation might be difficult to formulate and even more difficult to enforce. The answer to the problem may in part lie in more effective education by discussion with those persons concerned with breeding and supervision of cattle together with sensible recognition of the economic problems by both legislators and the consumer. The author believes that the veterinary profession should take a leading rôle in such discussions to ensure that the advances in the diagnosis, treatment and prevention of bovine dystocia over the past 150 years should not be halted through economic expediency.

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